User's Manual

Model 805
Temperature Controller

This manual applies to instruments with Serial Numbers from 18000 and subsequent.

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SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The information contained in this operations manual is for the installation, operation, remote programming and option and accessory information for the Lake Shore Cryotronics, Inc. Model 805 Temperature Controller. A separate Technical Service Guide is available for this instrument which contains performance and calibration procedures, schematics, component layouts and a replaceable parts list.

This section contains general information for the Lake Shore Cryotronics, Inc. 805 Temperature Controller. Included is an instrument description, specifications, instrument identification, option and accessory information.

1.2 DESCRIPTION

The 805 Temperature Controller is a microprocessor based instrument which provides true analog control. It accepts inputs from up to two sensors and displays the temperature with up to 4 digits of resolution in K, ^{o}C or ^{o}F. It displays voltage for diodes to 1 millivolt, and ohms for resistors to four places.

The dual sensor input allows the user to monitor temperature at more than one point. Sensor select pushbuttons on the front panel enable the user to display either input at will. The system control sensor is selected via a rear-panel toggle switch with the choice indicated on the front panel. This choice is independent of display status.

The Model 805 is direct reading in temperature when used with the Lake Shore DT-470 Series Temperature Sensors. All DT-470 Sensors follow the same temperature response curve. Four bands of tracking accuracy are offered so that sensor selection may be made with both technical and economical considerations for any given application. Low temperature (2 to 100K) accuracies range from 0.25K for band 11 to 1K for band 13. For more demanding requirements, DT-470 Sensors can be individually calibrated to accuracies of better than 50 millikelvin depending on temperature range.

Diode sensor voltages are digitized with a resolution of 100 microvolts out of 3 volts full scale. For the display, temperature is rounded to 0.1 kelvin above 100 kelvin, and to 0.01 kelvin below 100 kelvin.

For greater precision individual sensor calibrations can be accommodated through the 8001 Precision Calibration Option which programs the instrument with a particular response curve. The algorithm within the instrument interpolates between data points to an interpolation accuracy which exceeds 0.01K over the entire temperature range of the Precision Option. The analog-to-digital converter is accurate to plus or minus the least significant bit, which for the 470 series sensor results in an uncertainty of 1mK below 28K and 45mK above 40K with a transitional region between the two temperatures. Therefore, at temperatures below 28K, the overall system accuracy, the sum of the instrument accuracy (11mK) and that of the calibration itself (Lake Shore calibrations are typically better than 20mK within this region) is $\pm$0.03K. Above 28K, system accuracy gradually moderates to a typical value of $\pm$75mK above 40K. See the Lake Shore Cryotronics, Inc. Low Temperature Calibration Service brochure for additional discussion of calibration accuracy.

The 805 display uses digital filtering which averages up to ten temperature readings. This reading mode eliminates noise within the cryogenic system analogous to averaging with a digital voltmeter. This algorithm can be deselected (bypassed) by switch 2 of the SENSOR ID dip switch on the back panel for a given input if the user prefers not to average readings. A blinking decimal point at the upper left of the

display indicates that averaging is on.

The Model 805 can also be used with the optional input conversion modules (-6) which allow either input to be converted to handle either the TG-120 series diodes (or any diode with a 0 to 6 volt output), or positive temperature coefficient metallic resistors., i.e., platinum (-P2 or -P3) or rhodium-iron (-R1) resistors. The DIN curve is standard within the instrument and is called up automatically unless a precision option is present for the platinum resistor. The accuracy of the reading is dictated by the sensor and its conformity to the DIN curve. The tolerance on these devices is given on the technical data sheet for the Lake Shore PT-100 series sensors. The combined accuracy of the instrument and a calibrated resistor with a precision option is on the order of 40mK over the useful range of the sensor (above 40K for the platinum). Note that a precision option is required for a rhodium-iron or a TG-120 to read correctly in temperature.

These input conversion modules are easily installed by the user; thus, units can be modified to satisfy changing requirements.

The ample memory space provided in the 805 allows several response curves to be stored in one instrument. Depending on the complexity of the curves, up to ten can be programmed into the unit. The SENSOR ID switches are used to select which particular sensor response curve is to be used with each input. Thus, the user is able to make sensor changes at will even when different response curves are required.

The data for calibrated sensors can be stored within the instrument by means of the 8001 Precision Option. Each curve can contain up to 99 sensor unit-temperature data points. With the standard precision option format, which consists of 31 data points and a 20 character information line, up to ten curves can be stored in the unit. See Paragraphs 3-6 through 3-10 for more description.

Although voltage (resistance)-temperature data points are stored as a table, interpolation within the instrument results in the equivalent of a high order polynomial calculation in the converting of the input voltage (or resistance) to temperature. This is done by means of a proprietary algorithm developed at Lake Shore Cryotronics, Inc.

The control temperature set-point selection is made via thumbwheel switches on the front panel of the instrument. The set-point switches, which provide a continuous indication of the set-point value, enable the user to quickly and easily determine whether his system is at control temperature. The set-point is in the same units as is the Display sensor (kelvin, celsius, fahrenheit, or volts [ohms]).

The control section of the 805 provides two-term temperature control. Proportional (GAIN) and integral (RESET) are individually tuned via front-panel potentiometers. The gain mode is in a nominal log per cent with the reset being linear.

Analog heater output of the 805 Temperature Controller is a maximum of 25 watts when a 25 ohm heater is used. A digital meter on the front panel of the 805 continuously shows the heater power output as a percentage of output range. Thus, the user can conveniently monitor power applied to his system. To accommodate systems which require lower heater power, the maximum heater output of the 805 can be attenuated in two steps of a decade each. When greater power output is required, an optional 56 watt power output stage is available (W60) which is designed for a 25 ohm load. It is rated at a nominal 1.5 amperes and 45 volts.

An optional IEEE-488 (Model 8054) or RS-232C (Model 8053) interface is available for the 805. Either interface can be used to remotely control all front-panel functions.

1.3 INPUT OPTION MODULES

The input option modules for the 805 Controller are listed in Table 1.1.

Table 1.1. Input Option Modules, Model 805 Temperature Controller

Diode or Resistance Sensor (ordered separately):

DIODE SENSOR CONFIGURATION

Diode Excitation: DC current Source. 10 microamperes (±0.005%). AC noise from current source less than 0.01% of DC current.

Diode Voltage Range: 0 to 3 volts in standard configuration.

Diode Temperature Range: Dependent on Sensor selected. DT-470-SD covers temperature range from 1.4 to 475 kelvin. Refer to diode specifications for other temperature limitations.

Diode Response Curve(s): The silicon diode series DT-470 Curve #10 as well as the series DT-500 DRC-D and DRC-E curves are present in the 805. Curves to match other existing Sensors are available on request.

Diode Sensor Power Dissipation: Dissipation is the product of Sensor Excitation Current 10uA) and Resultant Sensor Voltage.

Accuracy: Unit reads sensor voltage to an accuracy of better than 0.1mV. Equivalent temperature accuracy is a function of Sensor type, temperature (sensitivity) and calibration of Sensor. See the Technical Data Sheet for the DT-470 Series Temperature Sensors and the Model 8001 Precision Option for accuracy with LSCI calibrated Sensors.

6-VOLT DIODE SENSOR MODULE

-6 Diode Sensor Input Module. Similar to standard configuration but has 0 to 6 volt input to accommodate TG-120 Series Sensors. Converts either Input A or Input B (or both with two modules) to accommodate the 6 volt modification for TG-120 series sensors. Requires calibrated sensor and 8001 Precision Option for 805 to be direct reading in temperature. This module may be field installed.

100 OHM PLATINUM MODULE

-P2 100 Ohm Platinum Sensor Module: Converts either Input A or B (or both with two modules) to accommodate 100 ohm Platinum RTD Sensors. This module may be field installed.

Temperature/Resistance Range: Temperature range depends on Sensor. Resistance in one range from 000.0 to 300.0 ohms.

Resolution: 0.01 ohm or equivalent temperature.

Sensor (order separately): Configuration optimized for PT100 Series Platinum Sensors or any other 100 ohm (at 0°C) positive temperature coefficient Sensor.

Sensor Excitation: 1.0 mA (±0.005%).

Sensor Response Curve: Platinum Sensor response curve is based on 0.1% interchangeability at 0°C and temperature coefficient (0-100°C) of 0.00385/°C. Accuracy conforms to DIN 43760 tolerances plus display (electronics). Special calibrations can be accommodated with 8001 Precision Option.

Sensor Power Dissipation: Dissipation is the product of sensor excitation current squared and the Sensor resistance.

1000 OHM PLATINUM MODULE

-P3 1000 Ohm Platinum Sensor Module: Essentially the same as the -P2 except accommodates 1000 ohm Platinum Sensor (or any other 1000 ohm metallic sensor). Sensor excitation is 0.1 milliampere. Unit reads resistance in ohms. Requires calibrated sensor and programmed calibration to read temperature. Accuracy is 0.1 ohm or equivalent temperature.

27 OHM RHODIUM-IRON MODULE

-R1 27-ohm Rhodium-Iron Sensor Module: Essentially the same as -P2 except accommodates RF-800-4 Rhodium-Iron Sensor. Sensor excitation is 1mA. Unit reads resistance in ohms. Requires calibrated sensor, etc. to read temperature. Accuracy and resolution is 0.003 ohms or equivalent temperature.

1.4 SPECIFICATIONS

Instrument specifications are listed in Table 1.2. These specifications are the performance standards or limits against which the instrument is tested.

Option ports are designed into the 805 to ease the addition of interfaces and outputs. The Model 805 has two option ports which allow up to two options to be used simultaneously (see limitations below). The options are easily installed by the user; thus, units can be changed or upgraded to satisfy changing requirements.

Only one computer interface can be installed in the 805 due to space limitations in the 805 rear-panel. The Model 8055 Analog Output option is available to provide an analog output of 1mV/K independent of the display temperature units. If the display is in sensor units, the output for diodes is 0.1V/V; for 100 ohm platinum, 1mV/ohm; for 1000 ohm platinum, 0.1mV/ohm; for rhodium-iron, 10mv/ohm.

Table 1.2. Specifications, Model 805 Temperature Controller

INPUT CHARACTERISTICS:

Inputs: Two Sensor Inputs. Control Sensor (A or B) selected via rear panel switch and indicated on the front panel. Display sensor (A or B) can be selected from front panel or interface, independent of control sensor. The input characteristics are a function of Sensor Input Module Installed. The 805 can accommodate separate input modules for the A and B input. This allows concurrent use of different sensor types.

Input Conversion Modules: Standard configuration for the 805 is both inputs set up to use DT-470 series silicon diode sensors (0-3V). Optional input conversion modules allow the 805 to be used with TG-120 series diode sensors (0-6V), as well as PT-100 series 100/1000 ohm platinum RTD's, and RF-800 series rhodium-iron sensors.

Input Conversion Module (one per input)	Sensor Type
-6*	6 volt diodes (e.g. TG-120)
-P2	100 ohm Platinum
-P3*	1000 ohm Platinum
-R1*	27 ohm rhodium-iron

* To read correctly in a temperature scale, these modules require the use of calibrated sensors and the 8001 Precision option for the 805.

Sensors: Ordered Separately. 805 with input conversion modules will handle all types of diodes as well as platinum and rhodium-iron RTD's and other positive temperature coefficient resistors with proper choice of input. See the Lake Shore Cryotronics, Inc. Sensor catalog for details on the above Sensors.

Sensor Response Selection: Rear-panel Dip switch or Interface permits selection of appropriate Sensor response curve when more than one curve is stored (see Precision Option).

DISPLAY READOUT:

Display: 4-digit LED Display of Sensor reading in Sensor Units (Volts or Ohms) or temperature in K, ^{o}C, or ^{o}F shown with annunciators.

Display Resolution: 0.1K above 100K, 0.01K below 100K, or 1 mV (0.1 ohm with resistance option)

Temperature Accuracy: Dependent on Sensor Input and Sensor. See Input Options available.

Temperature Range: Dependent on Sensor Input Module and Sensor.

Table 1.2. Specifications, Model 805 - Continued

TEMPERATURE CONTROL:

Set Point: Digital thumbwheel selection in kelvin, celsius, fahrenheit, or volts (ohms with resistance option).

Set Point Resolution: Same units and resolution as display.

Controllability: Typically better than 0.1K in a properly designed system.

Control Modes: Proportional (gain) and integral (reset) set via front-panel or with optional computer interface.

Heater output: Up to 25 watts (1A,25V) available. Three output ranges can be selected either from front-panel or from optional computer interface and provide approximate decade step reductions of maximum power output. Optional 60 watt, 1.5 ampere 25 ohm output (Option W60) is available for the 805.

Heater output Monitor: LED display continuously shows heater output as a percentage of output range with a resolution of 1%.

Control Sensor: Either Sensor Input (selected from rear panel).

GENERAL:

Sensor Voltage Monitor: Buffered output of each diode sensor voltage for standard configuration. For -6 option module, voltage output times 0.5. For positive temperature coefficient modules (-P2, -P3,-R1), buffer is sensor voltage output times-10.

Response time (electronics): Display update cycle time of less than 1 second (650 msec typical). 2 seconds (3 readings) on channel change or step change.

IEEE-488 Interface Option: Allows remote control of setpoint, gain, reset, units, display sensor and heater power range (except power on/off). Provides output of display, display units and all front panel functions.

RS-232C Interface Option: Controls same parameters as IEEE-488 Interface.

Dimensions, Weight: 216mm wide x 102mm high x 381mm deep (8.5in. x 4in. x 15in.), 5.5 kilograms (12 pounds).

Power: 100, 120, 220 or 240 VAC (selected via rear panel with instrument off), 50 or 60 Hz, 75 watts.

Accessories Supplied: Mating connector for sensor/monitor connector, operations manual.

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SECTION II

INSTALLATION

2.1 INTRODUCTION

This Section contains information and instructions pertaining to instrument set-up. Included are inspection procedures, power and grounding requirements, environmental information, bench and rack mounting instructions, a description of interface connectors, and repackaging instructions.

2.2 INITIAL INSPECTION

This instrument was electrically, mechanically and functionally inspected prior to shipment. It should be free from mechanical damage, and in perfect working order upon receipt. To confirm this, the instrument should be visually inspected for damage and tested electrically to detect any concealed damage upon receipt. Be sure to inventory all components supplied before discarding any shipping materials. If there is damage to the instrument in transit, be sure to file appropriate claims promptly with the carrier, and/or insurance company. Please advise Lake Shore Cryotronics, Inc. of such filings. In case of parts shortages, advise LSCI immediately. LSCI can not be responsible for any missing parts unless notified within 60 days of shipment. The standard Lake Shore Cryotronics Warranty is given on the first page of this manual.

2.3 PREPARATION FOR USE

2.3.1 Power Requirements

The Model 805 requires a power source of 50 to 60 Hz single phase 100, 120, 220 or 240 VAC (+5%, -10%).

CAUTION

Verify that the AC Line Voltage Selection Wheel (Figure 3-2, Key 1 located on the rear panel of the Model 805 is set to the AC voltage to be used (Table 2-1) and that the proper fuse is installed before inserting the power cord and turning on the instrument.

2.3.2 Power Cord

A three-prong detachable power cord for 120 VAC operation which mates with the rear panel UL/IEC/ICEE Standard plug is included with the instrument.

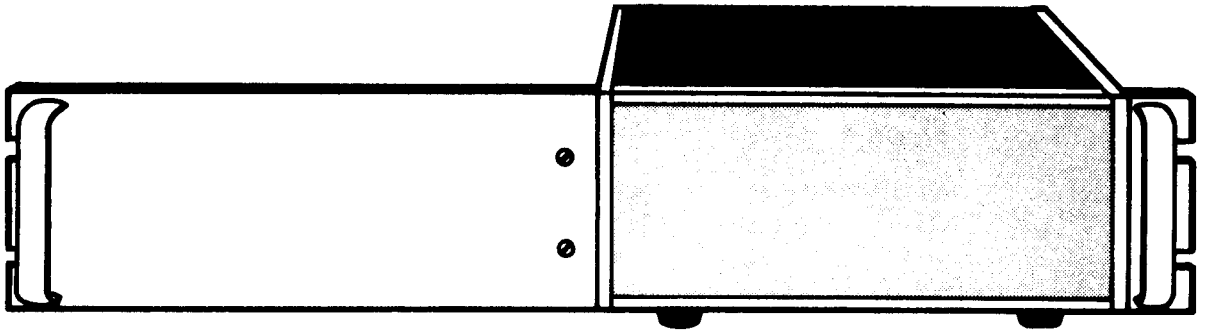
2.3.3 Grounding Requirements

To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends, and some local codes require, instrument panels and cabinets to be grounded. This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

Table 2-1. Line Voltage Selection

Line Voltage (Volts)	Operating Range (Volts)	Fuse (A)
100	90-105	1 - SB
120	108-126	1 - SB
220	198-231	0.5- SB
240	216-252	0.5- SB

Figure 2-1. Typical Rack Configuration



2.3.4 Bench Use

The 805 is shipped with feet and a tilt stand installed and is ready for use as a bench instrument. The front of the instrument may be elevated for convenience of operation and viewing by extending the tilt stand.

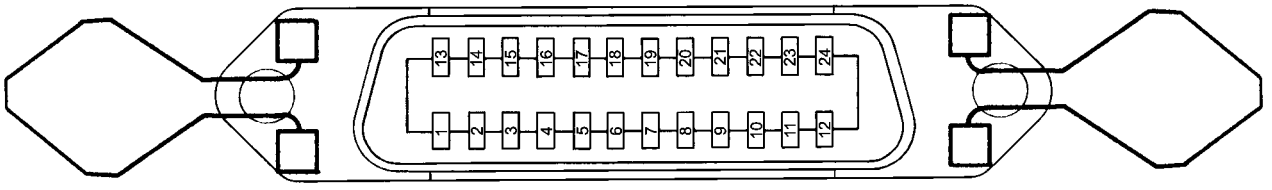
2.3.5 Rack Mounting

The 805 can be installed in a standard 19 inch instrument rack by using the optional RM-3H1 or RM-3H2 rack mounting kit. A typical RM-3H1 rack kit installations with handles is shown in Figure 2-1.

2.3.6 Sensor Input Connections

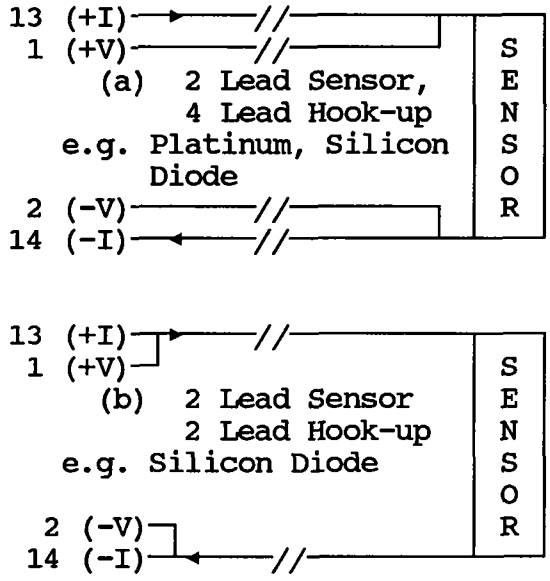
The Model 805 is supplied with a 24 pin rear panel mounted D-style connector for the connection of two sensors. The connection definition for the sensor(s) is given in Table 2-2 and is shown in Figure 2-2.

Table 2-2. Connector Plug Connections



Pin #	Function	Pin #	Function
1	+V A Input	13	+I A Input
2	-V A Input	14	-I A Input
3	SHIELD (A Input)	15	SHIELD (B Input)
4	+V B Input	16	+I B Input
5	-V B Input	17	-I B Input
6	+V Buffered Sensor -	18	+V Option 8055
7	-V Output Signal(A)	19	-V Analog Output
8	+V Buffered Sensor -	20	+5 VDC (10 mA LIMITED)
9	-V Output Signal(B)	21	DIGITAL GROUND
10		22	
11		23	
12		24	

Figure 2-2. Sensor Connections



The use of a four wire connection (Figure 2-2a) is highly recommended for resistive elements to avoid introducing IR drops in the voltage sensing pair which translates into a temperature measurement error. An alternate two line wiring method (Terminals A and E shorted together, B and D shorted) may be used for the DT-470 and TG-120 series diodes in less critical applications where lead resistance is small and small readout errors can be tolerated (b). Measurement errors due to lead resistance for a two lead diode hook-up can be calculated using; ∗T = IR/[dV/dT] where I is 10 microamperes, R is the total lead resistance; dV/dT is the diode sensitivity and ∗T is the measurement error. For example, R = 250 ohms with dV/dT = 2.5 millivolts/kelvin results in a temperature error of 1 kelvin. Two wire connections are not recommended for other sensor types.

The Lake Shore Cryotronics, Inc. QL-36 QUAD-LEAD™ 36 gauge cryogenic wire is ideal for connections to the sensor since the four leads are run together and colorcoded. The wire is phosphor Bronze with a formvar insulation and butryral bonding between the four leads.

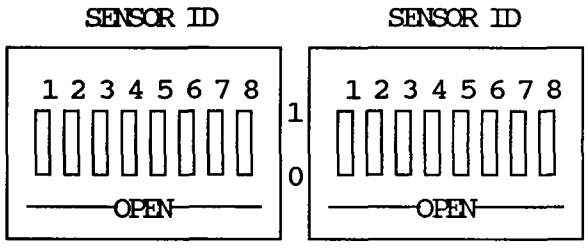
2.3.7 Sensor Output Monitors

Buffered voltage outputs of both Sensor A and Sensor B are available from the same connector on the back of the instrument. This connector also carries the Model 8055 Analog Output Option when present. The connector pin definitions are given in Table 2-2.

2.3.8 SENSOR ID Switches

The SENSOR A ID and SENSOR B ID switches are used to select stored sensor curves and to activate or deactivate digital filtering. The SENSOR ID switch information is described in Table 2-3 and Figure 2-3.

Figure 2-3. SENSOR ID Definitions



Input A Input B

Switch	Setting Description
1	OPEN - Negative T. C. CLOSED - Positive T. C.
2	OPEN - Continuous Update CLOSED - Digital Filtering On
3	OPEN - Thermal Considered CLOSED - No Thermal Considered
4	OPEN - Curve Selection CLOSED - Position selection
5	Multiple Bit 3
6	Multiple Bit 2
7	Multiple Bit 1
8	Multiple Bit 0

Table 2-3 gives the position of the address switches to call up standard curves stored within the instrument. Information on Pre-

cision Option Curves is given in Appendix B.

Curve #2 and Curve #4 differ in that Curve #2 has an upper temperature limit of 325K which limits the set point between 0 and 325K while Curve #4 has an upper limit of 475K and a corresponding upper limit for the set point.

Table 2-3. SENSOR ID Curve Address

SENSOR ID Switch 5	6	7	8	Curve #	Description
0	0	0	0	00	DRC-D
0	0	0	1	01	DRC-E1
0	0	1	0	02	CRV 10
0	0	1	1	03	DIN-PT
0	1	0	0	04	CRV 10

See SECTION III and Appendix B for more information on sensor selection and the operation of the SENSOR ID switches.

2.3.9 Heater Power

The heater output leads should be electrically isolated from the sensor(s) ground(s) to preclude the possibility of any of the heater current affecting the sensor input signal. The heater leads should not run coincident with the sensor leads due to the possibility of capacitive pick-up between the two sets of leads. If they are in close proximity, they should be wound so as to cross the sensor leads at ninety degrees if at all possible.

The heater output is a current drive and does not have to be fused. The 805 is designed to work with a 25 ohm heater for maximum heater output (25 watts). If a smaller resistance is used, the maximum heater power corresponds to the heater resistance, i.e., 10 ohms yields 10 watts. A larger heater resistance can also be used with the 805. For example, since the compliance voltage is slightly above 25 volts; a 50 ohm heater would result in a maximum power output of 12.5 watts $[(25)^2/50]$.

An optional (W60) output power stage of 60 watts is available for the 805. This output is also set up for a 25 ohm load with a maximum current of 1.5 amperes at approximately 43 volts.

Lake Shore recommends a 30 gauge stranded copper lead wire (Model ND-30) for use as lead wires to the heater.

2.4 OPTIONS

2.4.1 Model 8053 RS-232C INTERFACE Option. The RS-232C option is described in Section VI of this manual.

2.4.2 Model 8054 IEEE-488 INTERFACE Option. The IEEE option is described in Section VI of this manual.

2.4.3 Model 8055 Linear Analog Output Option. The Linear Analog Option is described in Appendix C of this Manual.

2.5 ENVIRONMENTAL REQUIREMENTS

WARNING

To prevent electrical fire or shock hazards, do not expose the instrument to excess moisture.

2.5.1 Operating Temperature

In order to meet and maintain the specifications in Table 1-1, the 805 should be operated at an ambient temperature range of 23°C ± 5°C. The unit may be operated within the range of 15-35°C with less accuracy.

2.5.2 Humidity/Altitude

The 805 is for laboratory use. Relative humidity and altitude specifications have not been determined for this unit.

2.6 REPACKAGING FOR SHIPMENT

If the Model 805 appears to be operating incorrectly, refer to the Technical Service Guide. If these tests indicate that there is a fault with the instrument, please contact LSCI or a factory representative for a returned Goods Authorization (RGA) number

before returning the instrument to our service department.

When returning an instrument for service, photocopy and complete the Service Form found at the back of this manual. The form should include:

1. Returned Goods Authorization No.
2. Instrument Model and Serial Numbers
3. User's Name, Company, Address, and Phone Number
4. Malfunction Symptoms
5. Description of Measurement system

If the original carton is available, repack the instrument in a plastic bag, place it in the carton using original spacers to protect protruding controls. Seal the carton with strong paper or nylon tape. Affix shipping labels and "FRAGILE" warnings.

If the original carton is not available, pack the instrument similar to the above procedure, being careful to use spacers or suitable packing material on all sides of the instrument.

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SECTION III

OPERATING INSTRUCTIONS

3.1 INTRODUCTION

This section contains information and instructions concerning the operation of the Model 805 Temperature Controller. Included is a description of the front and rear panel controls and indicators.

3.2 INSTRUMENT CONFIGURATION

3.2.1 Input Modules

The Model 805 can be used with several different input modules. These modules are summarized in Section I. Input modules can be mixed, allowing two different sensor types to be used with the 805, e.g., both a diode thermometer and a resistance thermometer could be used on the two inputs, with the addition of one optional input module.

3.3 PRECISION OPTIONS

There are two types of Precision Options available for the 805. The 8001 Precision Option is supplied for calibrated sensor(s) precision option data ordered at the same time as the 805.

The 8002 Precision Option is used when the customer already owns an 805 and wants new sensor calibration data stored in the instrument. LSCI stores the calibration data in a PROM chip and sends the programmed chip to the customer. The PROM is then installed in the 805 by the customer. Note: When ordering the 8002 Precision Option, specify the serial number of the 805.

Note that additional calibrations can be added to the instrument at a later time by specifying with the sensor calibration at time of order, the serial number of the instrument.

If a Precision Option is ordered from the factory, its curve number will be specified for the user and included in the manual as an addenda to the manual (see Appendix B).

Note: A proprietary algorithm is used to fit the precision option data to within a few millikelvin over the entire temperature range.

3.4 CONTROL FUNDAMENTALS

An application note entitled "Fundamentals for Usage of Cryogenic Temperature Controllers" is included as an appendix in this manual and should be read in detail if you are not familiar with cryogenic temperature controllers.

3.5 CONTROLS AND INDICATORS

Figures 3-1 and 3-2 identify the 805 displays, annunciators, controls, and connectors. The identification of each item is keyed in the appropriate figure.

FRONT PANEL DESCRIPTION

3.6 POWER ON/OFF Switch

Before connecting AC power to the 805, make sure the rear panel voltage selector is set to correspond to the available power line voltage. Be certain the correct fuse is installed in the instrument.

3.6.1 POWER UP SEQUENCE

Immediately on POWER ON the 805 runs through a power up sequence as follows:

1. The Display indicates $\pm$8.8.8.8 and the Heater % indicates 188. In addition all annunciators and LED's are turned on. The LED's include: SENSOR A and B, CONTROL SENSOR A and B as well as four sets of units; HEATER POWER (LO, MED, HI); + and -; 2 decimal points for set point and if a resistance module is present, an ohms indicator; and with an optional computer interface, the LOCAL/REMOTE indicators.

2. Next, the unit displays 805 in the display window and, if present, indicates the IEEE-488 interface address in the HEATER % window. This address can be changed by the user and verification is always given on power-up. Note that any changes in the IEEE-488 address are only recognized and read by the instrument on power-up.

3. The unit then displays for INPUT A the module associated with that input in the display window as well as the SENSOR A ID curve number in the HEATER % window.

4. The unit then displays the same information for Input B.

5. The unit then goes into normal operation.

3.7 DISPLAY SENSOR Block

3.7.1 DISPLAY SENSOR Input

The choice of Display SENSOR input is made by pushbuttons on the front panel which allows the user to display either input and indicate by an annunciator the sensor input which is currently displayed.

3.7.2 Units Select

The UNITS key is used to change the display and control units. The key is located below the lower right corner of the display window. Pressing the key scrolls the units, i.e., K °F V °C K etc. The selected units are displayed to the right of the HEATER % power display. The units display light is blinked to indicate the frequency of display update.

The temperature units for both inputs are selected by the units button and are kept the same to avoid confusion.

3.7.3 Display SENSOR Units

3.7.3.1 Voltage Units

In the voltage mode, the display has a resolution of 1 millivolt and a full scale input of 3.000 volts (6.553 volts for the -6 module). If an input exceeding 3.000 volts (or 6.553 volts for the -6 module) is applied to the displayed input, an overload condition is present and is indicated by an OL on the display.

3.7.3.2 Resistance Units

The Resistance mode requires the -P2, -P3, or -R1 input conversion module(s).

The display ranges and resolutions for the -P2, -P3 and -R1 are 0.0 to 299.9 ohms, 0 to 2999 and 0.0 to 100.0 ohms respectively. If a resistance exceeding full scale is applied to the input, OL is indicated on the display.

3.7.3.3 Temperature Units

In kelvin temperature units, the chosen input is displayed with a display resolution of 0.1 degree above 100 kelvin and 0.01 degree between 1 and 100 kelvin. Note that this is **display** resolution and **not** system resolution **or** accuracy of the reading. If the sensitivity of the sensor is too low to support this resolution, i.e., one bit corresponds to greater than the above resolution, some temperatures may be skipped. This will be true for a silicon diode sensor between 30 kelvin and 100 kelvin where the sensitivity is approximately 2.5 millivolts per kelvin and the voltage resolution is 0.046 millivolts. For this case, the resulting temperature resolution is 0.046/2.5 = 0.018 kelvin. However, below 30 kelvin the silicon diode sensitivity is approximately 25 millivolts per kelvin which results in an approximate resolution of 0.002 kelvin (0.046/25).

For the celsius and fahrenheit scales, resolution is 0.01 degree within 100 degrees of their respective zeros and 0.1 degree outside this band for either positive or negative temperatures.

3.7.4 Filtering the Display

An averaging algorithm within the instrument is available which averages up to ten readings. This reading mode eliminates noise within the cryogenic system analogous to averaging within a digital voltmeter.

Figure 3-1. Model 805 Temperature Controller Front Panel Description

1. Units selector button with annunciators in kelvin, celsius, fahrenheit or sensor units (volts or resistance).

2. Annunciated SENSOR Selector buttons (A or B) for display sensor.

3. Display sensor reading in units selected (see Key 1) with filter indication.

4. HEATER POWER full scale selector buttons with annunciators (LO = 10^{-2}, MED = 10^{-1}, HI = 10^{0} [or 1] times 25 watts).

5. Per cent power meter. Power out equals meter reading times range selection times 25 watts with 25 ohm heater.

6. CONTROL SENSOR annunciator (A or B) as selected on rear panel.

7. POWER ON-OFF switch.

8. Variable GAIN (proportional) control.

9. Variable RESET (integral) control with OFF detent.

10. Digital set-point in selected units (see Key 1) with annunciators for decimal point.

11. Sign selector button for set point with + and - annunciators when selected units (see Key 1) are in celsius or fahrenheit.

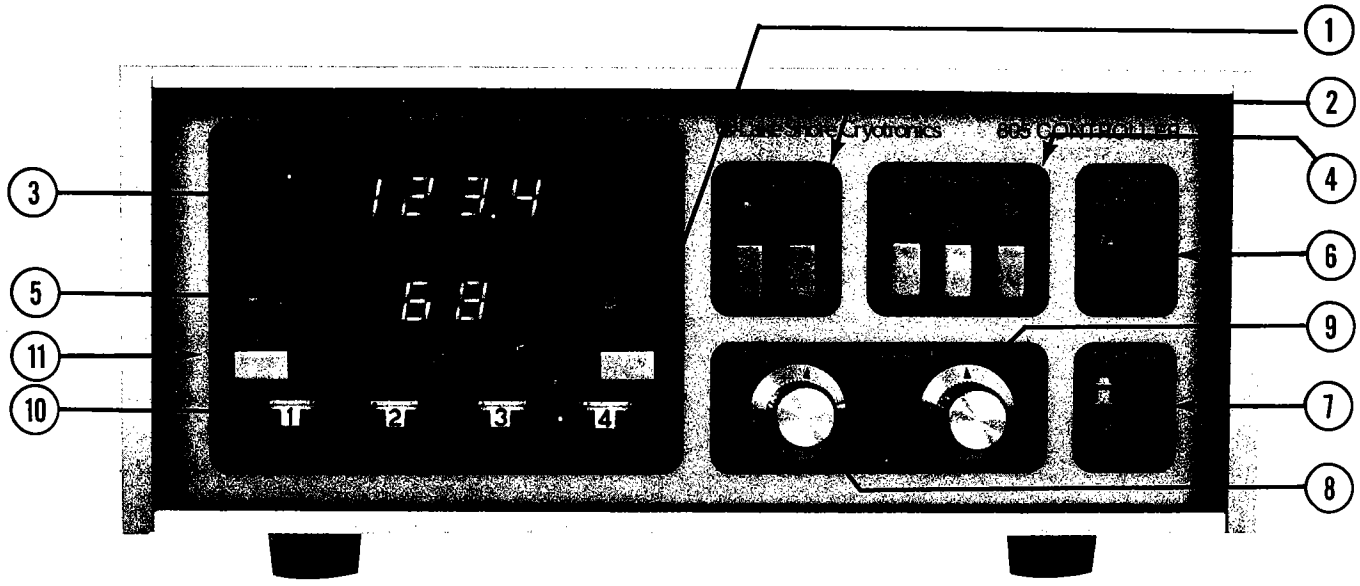


Figure 3-1. Model 805 Temperature Controller Front Panel

This function can be selected or deselected by switch 2 of the SENSOR ID on the back panel for each input separately. The 805 is shipped from the factory with the filtering function selected.

The decimal point on the sign digit at the far left of the display window flags "Filter-on" and will indicate whether the averaging algorithm is being used.

If the averaging algorithm is used, displayed temperature is on the average of somewhere between 1 and ten readings depending on the temperature variation. If an abrupt change in temperature is observed, averaging is disabled and the last calculated reading is displayed. As the disturbance is reduced in value, the averaging gradually increases until a total of ten readings are considered.

3.8 CONTROL BLOCK

3.8.1 CONTROL SENSOR

The choice of input for the CONTROL SENSOR is made by a switch labeled CONTROL on the rear panel. This switch chooses either INPUT A or INPUT B for control and lights the appropriate display light on the front panel.

3.8.2 SET-POINT

Set-point selection is made via thumbwheel switches on the front panel. The set-point switches, which provide a continuous indication of the set-point value, enable the user to quickly and easily determine whether his system is at the control temperature.

The temperature set-point has the same units and range as the display sensor. The selected units are annunciated on the front panel. The set-point limits are determined by the sensor curve being used for the control sensor input.

If a selected temperature set-point is outside of the control sensor's response curve temperature range, the set-point is set in software equivalent to 0 K which shuts down the heater output stage and the output meter reads 0 and blinks to indicate an out of range set-point.

The resistance limit ranges are given in Section 3.8.2.2. If a resistance set-point above the appropriate resistance limit in ohms is set, the set-point is set in software equivalent to zero resistance (0 K equivalent) which shuts down the output stage.

The +/- key is used to toggle the set-point plus or minus when in °C or °F only. The +/- key is inactive when in K, V or R since these units are always positive.

3.8.3 GAIN

The GAIN (proportional) knob allows adjustment of overall controller gain in the range of 1 to 1000. Maximum gain is full clockwise. Logarithmic scaling is used; therefore a gain setting of x100 is approximately two-thirds of full rotation. Refer to Figure 3-3a for nominal values.

3.8.4 RESET

The RESET knob adjusts the reset (integral) function of the controller in beats per second. One beat equals one integration period. The settings range from 0.001 beats per second (1000 seconds) to 1 beat per second (full clockwise) on a logarithmic scale. Detented counterclockwise setting is off. Refer to Figure 3-3b for nominal values.

Table 3-1. Reset Settings

SETTING - LOG %	TIME (SEC)	BPS
0.0 (OFF)	OFF	-
0.1 (10^{-1})	1000	0.001
0.5	300	0.003
1.0 (10^{0})	100	0.01
5.0	30	0.03
10 (10^{1})	10	0.1
50	3	0.3
100	1	1.

3.8.5 HEATER %

The HEATER % display can be set to read in per cent of power $[I/I_{max}]^2$ or percent of maximum current by the position of switch #1 of the internal configuration dip switch package S4 which is located on the

Figure 3-2. Model 805 Temperature Controller
Rear Panel Description

1. Line cord receptacle with fuse and voltage selection

2. J1 SENSORS/MONITORS input/output receptacle

3. HEATER power output terminals

4. SENSOR B ID

5. SENSOR A ID

6. Control Sensor Selector Switch

7. J2 (CLASS 2) Option Port for Model 8053 RS-232C Interface or Model 8054 IEEE-488 Interface.

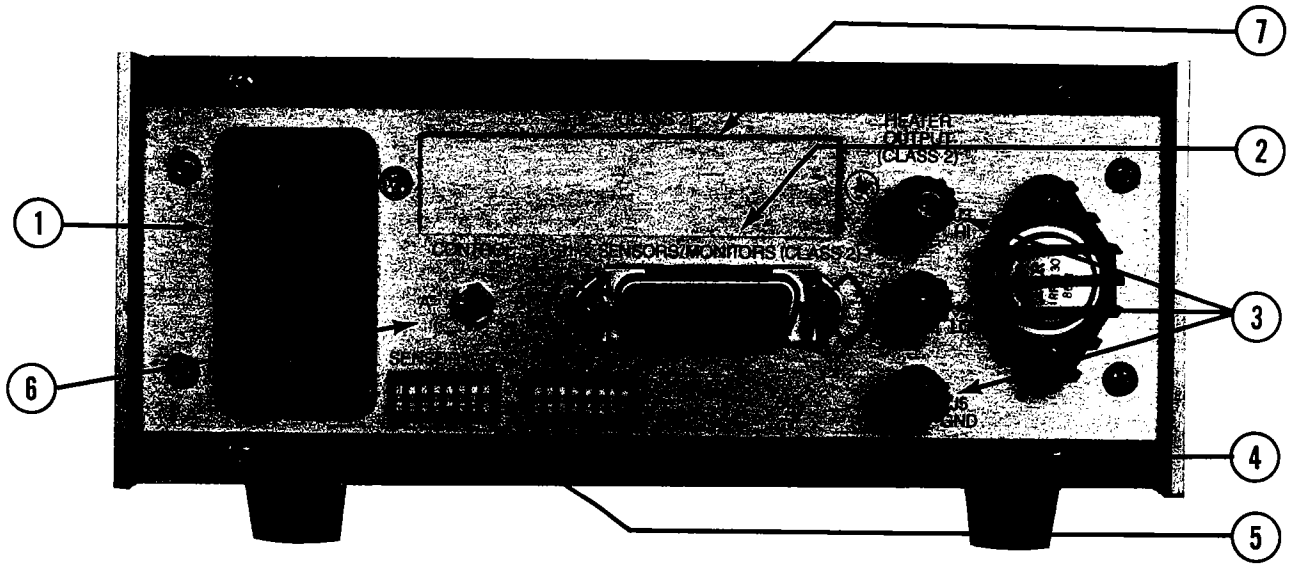


Figure 3-2. Model 805 Temperature Controller
Rear Panel

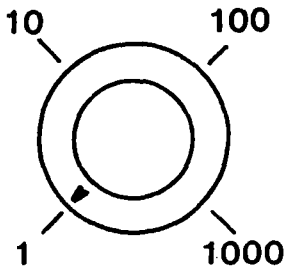
main board. The instrument is shipped from the factory with switch one of S4 off which results in the display reading in per cent power.

The HEATER % display is located directly below the temperature display. It displays the magnitude of the heater power or current in per cent of full scale (0% - 100%). Full scale in power is defined as the product of the load resistance times the HEATER POWER range setting.

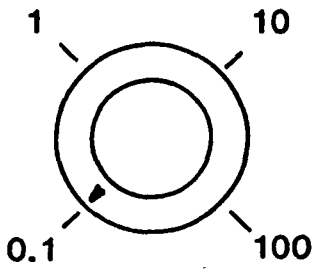
3.8.6 HEATER POWER Range

The HEATER POWER setting is determined by the switches directly below the analog HEATER POWER indicator. HI corresponds to 10^0 or 1 while MED and LO correspond to 10^{-1} and 10^{-2}, respectively. Full scale in current is either 1 ampere, 300 milliamperes or 100 milliamperes which correspond to the HEATER POWER range settings of HI, MED or LO respectively.

Figure 3-3. Nominal Gain and Reset Settings



3-3a. Nominal Gain Settings



3-3b. Nominal Reset Settings (Beats/Second)

The power output stage can be turned OFF by depressing the LO, MED or HI button whose annunciator is on. This action turns off the output power independent of the set-point and the control parameters.

3.9 LOCAL/REMOTE OPERATION

If either the IEEE-488 option or the RS-232C option is present in the 805, pressing the input DISPLAY key currently chosen toggles the 805 between REMOTE and LOCAL operation.

LOCAL indicates front-panel control. When returned to LOCAL, the display shows the curve number for the display SENSOR indicated.

When placed in REMOTE, the controller is under remote control and the front panel controls are disabled. The display shows the IEEE-488 address when placed in remote if the key is held down for over one second.

REAR PANEL DESCRIPTION.

3.10 CONTROL Switch

The CONTROL switch selects either the INPUT A or INPUT B signal to be fed to the control section of the controller. Since this selection is hard-wired through the switch, this choice can not be changed over either of the optional computer interfaces.

3.11 HEATER Power Output Terminals

The heater power output is rated at one ampere dc with a 25 volt compliance. The grey (HI) terminal is the high side and the black (LO) terminal is the low side. The black (GND) terminal, if connected, should be tied to the LO terminal. It will normally not be used.

3.12 SENSORS/MONITORS

The connections for the SENSORS/MONITORS plug is given in Table 2-2.

3.13 SENSOR CURVE SELECTION

The 805 software interrogates the appropriate SENSOR ID switch (i.e., A or B) to determine which standard curve or Precision Option curve has been selected (Switches 5-8). The standard curves and their switch position are given in Table 3-2. The ID switch functions are defined in Figure 3-4.

Table 3-2. Standard Curve Information

Curve No.	Switch 5678	Temperature Range (K)	Description
00	0000	1 - 324.9	DRC-D
01	0001	1 - 324.9	DRC-E1
02	0010	1 - 324.9	CRV 10
03	0011	14 - 799.9	DIN-PT
04	0100	1 - 474.9	CRV 10

Sixteen curves (00 through 15) can be selected from the SENSOR ID switches.

3.13.1 Display of Accessed Curve

To determine which curve that you are using is a simple matter for the 805. Select either the A or B input and depress and hold the Input key. After approximately one second, the display will show the following format:

A 02
d3

The above example indicates that no input module is installed in Input A and that the input is reading Curve 2, which from Table 3-1 we know is the CRV 10 for the DT-470 Series Sensors.

Since the 805 knows which type of input module is present for each input it will not, for example, allow the selection of the platinum curve (Curve No. 03) for a diode card. If Curve 03 is selected from the back panel SENSOR ID switch, the 805 will default to the lowest curve number with the correct temperature coefficient, in this case, curve 00. For the case of a platinum module and no Precision Option curves present, the 805 will select Curve Number 03, regardless of the settings for switches 4-8.

The input module and curve number for each input is also displayed on Power Up for a fraction of a second.

It is possible to store up to 16 curves total in the 805. These additional Precision Option Curves (10 possible), if present, can be accessed for each input through the SENSOR ID associated with each input.

3.13.2 The Precision Option Table

Table 3-3 gives the standard curves present in the 805 as well as any Precision Options which are factory installed including their address and the number of data points associated with each curve. This Table should be updated for the instrument if additional curves are added at a later time.

Up to 10 Precision Option Curves can be stored in the 805 with an average of 31 lines per curve. A Precision Option Curve can have up to 97 points with two additional end points automatically put into the curve table by the 805 software.

Table 3-3. Sensor Curve Table Information
Precision Option Table

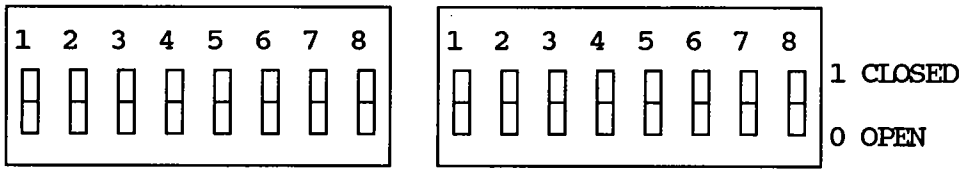
Curve	# of Lines	Address	Description
00	31	1D40	DRC-D
01	31	1DF0	DRC-E1
02	31	1EA0	CRV 10
03	31	1F50	DIN-PT
04	31	2000	CRV 10
05	31	20B0	RESVRD
06	____	_____	_____
07	____	_____	_____
08	____	_____	_____
09	____	_____	_____
10	____	_____	_____
11	____	_____	_____
12	____	_____	_____
13	____	_____	_____
14	____	_____	_____
15	____	_____	_____

Note: For Lake Shore stored Precision Option Curves, a proprietary algorithm is used to fit the calibration data to within a few millikelvin over the entire temperature range.

3.14 SENSOR ID Switches

The SENSOR ID switches select the appropriate standard curve or the Precision Option(s) curve stored in the instrument as well as activate or deactivate digital filtering. The switch information is described in Figure 3-4.

Figure 3-4. SENSOR ID Definitions



Switch No.	Description
1	-RESERVED
2	-OPEN - Continuous Update CLOSED - Mean of 10 readings
3	-RESERVED
4	-RESERVED
5	Multiple bit 3 (2^3)
6	bit 2 (2^2)
7	bit 1 (2^1)
8	bit 0 (2^0)

SECTION IV

REMOTE OPERATION

4.1 IEEE-488 INTERFACE (OPTION 8054)

The IEEE-488 INTERFACE is an instrumentation bus with hardware and programming standards designed to simplify instrument interfacing. The OPTIONAL IEEE-488 INTERFACE of the 805 fully complies with the IEEE-488-1978 standard and incorporates the functional, electrical and mechanical specifications of the standard. It also follows the supplement to that standard titled "Code and Format Conventions for use with IEEE Standard 488-1978". This section contains general bus information, Model 805 interface capabilities, addressing and programming instructions that control the 805 functions.

4.2 GENERAL IEEE SPECIFICATIONS AND OPERATION

The following discussion covers the general operation of the IEEE-488 interface. For a more detailed description of signal level and interaction, refer to the IEEE Standard 488-1978 publication "IEEE Standard Digital Interface for Programmable Instrumentation".

All instruments on the interface bus must be able to perform the interface functions of TALKER, LISTENER, or CONTROLLER. A TALKER transmits data onto the bus to other devices. A LISTENER receives data from other devices through the bus. Some devices perform both functions. The CONTROLLER designates to the devices on the bus which function to perform.

The interface works on a party line basis with all devices on the bus connected in parallel. All the active circuitry of the bus is contained within the individual devices with the cable connecting all the devices in parallel to allow the transfer of data between all devices on the bus.

There are 16 signal lines contained on the bus:

1. 8 Data Lines
2. 3 Byte Transfer Control Lines
3. 5 General Interface Management Lines

The data lines consist of 8 signal lines that carry data in a bit parallel, byte serial format. These lines carry universal commands, addresses, program data, measurement data and status to all the devices on the bus. The controller designates the functions of the units on the bus by setting the ATN line low (true) and sending talk or listen addresses on the DATA lines. When the ATN line is low, all devices listen to the DATA lines. When the ATN line goes high (false), then the devices addressed to send or receive data perform their functions while all others ignore the DATA lines.

Transfer of the information on the data lines is accomplished through the use of three signal lines: DAV (Data Valid), NRFD (Not Ready for Data) and NDAC (Not Data Accepted). These signals operate in an interlocking hand-shake mode. The two signal lines, NRFD and NDAC, are each connected in a logical AND to all devices connected to the bus. The DAV is sent by the talker and received by listeners while the NRFD and NDAC are sent by listeners back to the talker.

The General Interface Management Lines manage the bus and control the orderly flow of commands on the bus. The IFC (Interface Clear) message basically clears the interface to a known state appropriate to the device being addressed. SRQ (Service Request) is used by a device to indicate the need for attention or service and to request an interruption of data flow. REN (Remote Enable) is used to select between two sources of device data (as an example: front panel or rear panel controls on a measurement device). EOI (End or Identify) indicates the end of a multiple byte transfer sequence, or along with the ATN line, executes a polling sequence.

4.3 INTERFACE CAPABILITIES

The IEEE-488 Interface capabilities of the Model 805 are listed in Table 4-1 as well as

in mnemonic format on the instrument's rear panel.

Table 4-1. Interface Functions.

Mnemonic	Interface Function Name
SH1	Source Handshake Capability
AH1	Acceptor Handshake Capability
T7	Basic Talker, no serial poll capability, Talk only, Unaddressed to Talk if addressed to Listen
L3	Basic Listener, Listen only mode, Unaddressed to Listen if it is addressed to Talk
SR0	No Service Request capability
RL1	Complete Remote/Local capability
PP0	No Parallel Poll capability
DC1	Full Device Clear capability
DT0	No Device Trigger capability
C0	No System Controller capability
E1	Open Collector Driver Electronics

4.4 805 IEEE-488 ADDRESS SWITCH

The IEEE-488 Address Switch is located on the instrument's rear panel (see Figure 3-4, Key No. 9). Refer to Figure 4-1 for an explanation of the switch settings.

4.4.1 Terminating Characters (delimiters)

Switch 1 (*) is used to define the instrument's terminating characters (delimiters). The OPEN (0) position selects the ASCII characters CR and LF (Carriage Return and Line Feed) as the terminating characters for input and output data. For the output data from the 805 back to the computer over the Bus, the EOI (end of information) line is set by the 805 with the output of the Line Feed (LF). This setting (0) for switch 1 is the setting for all Hewlett-Packard computers.

When Switch 1 (*) is CLOSED (1), a variable terminating character format may be selected for the input and output data. In this configuration the power-up (default) terminating characters are LF and CR with the EOI line being set by the with the output of the Carriage Return (CR). However, the two terminating characters can be changed via input data to the 805 as detailed in Table 4-4. If the terminating characters are changed by the user, these become the new default terminating characters upon power-up with Switch 1 (*) CLOSED.

4.4.2 Talker and/or Listener Configuration

Since the controller is both a Talker and a Listener, normally switches two and three should both be OPEN (0). These switches are usually of use when one instrument is a Talker and another instrument is a Listener and they are to share the same address.

4.4.3 The IEEE-488 INTERFACE bus address for the 805 is set by switches 4 through 8 which are reserved for the address selection. Switch 4 is the most significant bit (MSB[=16]) and 8 is the least significant bit (LSB[=1]).

The factory preset address of this instrument is 12. Address switch numbers 5 and 6 should be CLOSED (1) which will result in the Address Switch having a setting of 00001100 or 10001100 dependent on the requirements for the delimiters.

4.5 IEEE-488 BUS COMMANDS

4.5.1 Uniline Commands are sent by setting the corresponding bus line true. ATN, IFC and REN are asserted only by the controller. EOI may be asserted either by the controller or the 805 depending on the direction of data transfer. The following is a description of each command. Each command is sent by setting the corresponding bus line true.

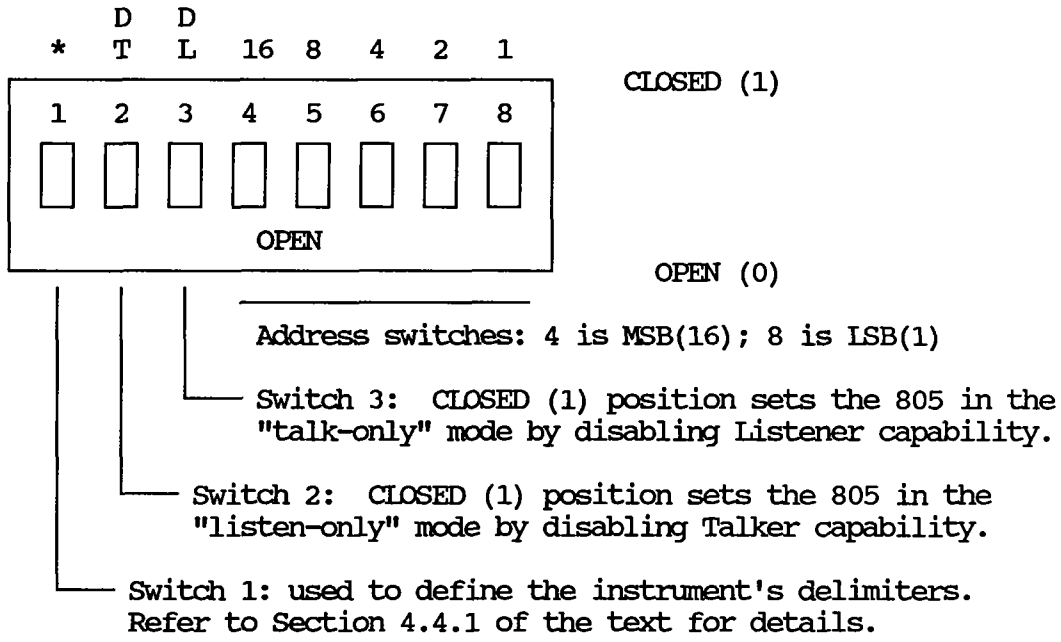
ATN (Attention)-The controller sends ATN while transmitting addresses or multiline commands.

IFC (Interface Clear)-IFC is used to clear the interface and return all devices to the talker and listener idle states.

REN (Remote Enable) - REN is sent to set up instruments on the bus for remote operation. Generally, REN should be sent before attempting to program instruments over the bus.

EOI (End or Identify)-EOI is used to positively identify the last byte in a multi-byte transfer sequence, thus allowing data words of various lengths to be transmitted easily.

Figure 4-1. IEEE-488 Address Switch for the 805


D D
* T L 16 8 4 2 1
1 2 3 4 5 6 7 8
CLOSED (1)
OPEN
OPEN (0)
Address switches: 4 is MSB(16); 8 is LSB(1)
Switch 3: CLOSED (1) position sets the 805 in the "talk-only" mode by disabling Listener capability.
Switch 2: CLOSED (1) position sets the 805 in the "listen-only" mode by disabling Talker capability.
Switch 1: used to define the instrument's delimiters. Refer to Section 4.4.1 of the text for details.

4.5.2 Universal Commands are those multiline commands that require no addressing. All devices equipped to implement such commands will do so simultaneously when the command is transmitted. As with all multiline commands, these commands are transmitted with ATN true.

LLO (Local Lockout)-LLO is sent to instruments to lock out their front panel controls.

DCL (device Clear)-DCL is used to return instruments to some default state. Usually, instruments return to their power-up conditions.

4.5.3 Addressed Commands are multiline commands that must be preceded by the device listen address before that instrument will respond to the command in question. Note that only the addressed device will respond to these commands.

SDC (Selective Device Clear)-The SDC command performs essentially the same function as the DCL command except that only the addressed device responds. Generally, instruments return to their power-up default conditions when responding to the SDC command.

GTL (Go To Local)-The GTL command is used to remove instruments from the remote mode. With some instruments, GTL also unlocks front panel controls if they were previously locked out with the LLO command.

4.5.4 Unaddress Commands are used by the controller to remove any talkers or listeners from the bus. ATN is true when these commands are asserted.

UNL (Unlisten) - Listeners are placed in the listener idle state by the UNL command.

UNT (Untalk) - Any previously commanded talkers will be placed in the talker idle state by the UNT command.

Table 4-3 summarizes the IEEE-488 Bus Commands acknowledged by the 805.

4.5.5 Device-Dependent Commands

The meaning of the device-dependent commands will depend on the configuration of the instrument. Generally these commands are sent as one or more ASCII characters that tell the device to perform a specific function. For example, the command sequence F0K is used to select kelvin as the set point units. The IEEE-488 bus actually treats these commands as data in that ATN is false when the commands are transmitted.

Table 4-2. Allowable Address Codes for the 805
(Factory preset address is decimal 12)

ASCII Code Character		Bit 2*	3	Address Switches 4	5	6	7	8	5-bit Decimal Code
Listen	Talk	B7	B6	B5	B4	B3	B2	B1	
SP	@	0	0	0	0	0	0	0	00
!	A	0	0	0	0	0	0	1	01
"	B	0	0	0	0	0	1	0	02
#	C	0	0	0	0	0	1	1	03
$	D	0	0	0	0	1	0	0	04
%	E	0	0	0	0	1	0	1	05
&	F	0	0	0	0	1	1	0	06
'	G	0	0	0	0	1	1	1	07
(	H	0	0	0	1	0	0	0	08
)	I	0	0	0	1	0	0	1	09
*	J	0	0	0	1	0	1	0	10
+	K	0	0	0	1	0	1	1	11
,	L	0	0	0	1	1	0	0	12
-	M	0	0	0	1	1	0	1	13
.	N	0	0	0	1	1	1	0	14
/	O	0	0	0	1	1	1	1	15
0	P	0	0	1	0	0	0	0	16
1	Q	0	0	1	0	0	0	1	17
2	R	0	0	1	0	0	1	0	18
3	S	0	0	1	0	0	1	1	19
4	T	0	0	1	0	1	0	0	20
5	U	0	0	1	0	1	0	1	21
6	V	0	0	1	0	1	1	0	22
7	W	0	0	1	0	1	1	1	23
8	X	0	0	1	1	0	0	0	24
9	Y	0	0	1	1	0	0	1	25
:	Z	0	0	1	1	0	1	0	26
;	[	0	0	1	1	0	1	1	27
<	\	0	0	1	1	1	0	0	28
=	]	0	0	1	1	1	0	1	29
>	~	0	0	1	1	1	1	0	30

Factory preset address

* Only the first five bits of the binary code are listed. These bits are the same for the TALK and LISTEN address. The sixth and seventh bits (controller originated) determine whether the instrument is being addressed to TALK or LISTEN.

Function	Bit 2	3
TALK	1	0
LISTEN	0	1

4.5.6 Talker and Listener Status

For the 805 to be a listener, it has to be in REMOTE and can be returned to LOCAL with the MO or GTL command as desired.

For most, but not all computers, the 805 as a talker does not have to be placed in REMOTE operation, but can remain under LOCAL control. This allows the user to collect data while maintaining front panel control. The HP computers will allow this mode of operation. If your computer automatically places the 805 in remote and keeps it in remote after the transmission is over, sending the additional command MO after the request for data will return the 805 to LOCAL.

4.6 PROGRAMMING INSTRUCTIONS

The following discussion references the 805 at address 12. The allowable address codes are given in Table 4-2; the 805's Talk ASCII Code is "L" and its Listener ASCII Code is "," (comma). The controller referred to in the following discussion is the bus controller and is normally a computer. It should not be confused with the temperature controller on the bus (805).

Set the IEEE Address of the 805 to 12 by making Switches 5 and 6 CLOSED (1), 4, 7 and 8 OPEN (0) and make sure Switch 1 is OPEN (0) to select (CR)(LF) as the terminating characters. Note that this should be done prior to turning on the instrument since the 805 updates the IEEE Address on power-up only. Confirm that the address selected is correct by holding in the SENSOR button whose annunciator is already lit when in REMOTE and observe the IEEE address on the front panel display as follows:

Add
12

4.6.1 Input Data Format and Program Codes

In addition to the IEEE-488 Bus Message Commands which most IEEE instruments respond to, the 805 receives the Program Codes which are given in Tables 4-4 and 4-5. The 805 must be addressed as a "Listener" and be in REMOTE to receive any instruction or string of instructions from the Program Code list.

The 805 input data format does not require a set number or set sequence of Program Codes to implement proper instrument set-up. These Program Codes are processed only after the terminators [TERM1] [TERM2] are sent across the bus. The listing and explanation of the 805's programming codes are given in Tables 4-4 and 4-5 and in the following text.

Table 4-3. IEEE-488 Bus Commands

Message Mnemonic	HP9825A Command	HP85 Command	IEEE-488 Bus Format
Uniline Commands			
Remote/REN	rem712	REMOTE712	?U,
Interface Clear/IFC			(IFC)
Universal Commands			
Local Lock Out/LLO	llo7	LOCAL LOCKOUT 7	7U(LLO)
Device Clear/DCL	clr7	CLEAR7	?U(DCL)
Addressed Commands			
Selected Device Clear/SDC	clr712	CLEAR712	?U,(SDC)
Go to Local/GTL	lcl712	LOCAL712	?U,(GTL)
Unaddress Commands			
Unlisten/UNL			?
Untalk/UNT			-

4.7 INSTRUMENT SETUP PROGRAM CODES (see Table 4-4)

4.7.1 EOI Status - The ZN_1 Command

When EOI (end or identify) is enabled ("Z0"); Table 4-4), the EOI line is set active concurrent with the last byte of the transfer. Use of EOI identifies the last byte allowing for variable length data transmissions. EOI can be disabled ("Z1"; Table 4-4).

4.7.2 Interface Mode - the MN_1 Command

4.7.2.1 Local

This message ["M0"; Table 4-4] clears the remote operation of the 805 and enables front panel operation. Pressing the front panel LOCAL button also sets the instrument to local, provided the button has not been disabled by the Local Lockout Message (see Section 4.7.2.3).

4.7.2.2 Remote

The 805 is in the local front panel mode when first turned on. A remote message ["M1"; see Table 4-4] allows the 805 to be controlled over the IEEE-488 interface. In Remote, the front panel controls are disabled (except the LOCAL button) and are then controllable over the IEEE Bus. The instrument's initial set up is determined by the front panel settings at the time which the instrument is placed into Remote. The 805 may also be placed into remote by pressing the REMOTE button on the front panel.

4.7.2.3 Local Lockout

This message ["M2"; Table 4-4] disables the 805's Local Front Panel controls, including the LOCAL button. The message is in effect until the message is cleared over the Bus or power is cycled.

Many IEEE-488 cards (for IBM PC's) automatically place addressed instruments into Local Lockout. To be able to place the DRC-91C into Remote without Local Lockout the user may need to reconfigure his IEEE-488 card.

4.7.3 Terminating Characters - The TN_1 Command

Terminating characters ["T1", "T2", "T3" and "T4"; Table 4-4] are used to indicate the end of a record. Record terminators are used when the unit has completed its message transfer. Switch 1 of the IEEE address defines the terminator status. If switch 1 is OPEN (0) the terminator status is defined as "T0" [(CR)(LF)] and terminator status can not be changed over the interface. When switch 1 is CLOSED (1) the terminator status is defined as "T1" [(LF)(CR)] and the status can be changed using the "T0", "T1", "T2" or "T3" commands.

4.7.4 Clear

The (C)lear Message [see Table 4-4] sets the 805 to the turn-on state. This action is similar to turning the instrument OFF and then turning it back ON, except that it occurs in milliseconds, rather than seconds.

4.8 SELECTION OF SET POINT UNITS AND DISPLAY SENSOR (Table 4-4)

4.8.1 Units for Set Point-The FOC_1 Command

The FOC_1 command set the temperature or sensor units for the set point. Note that only one choice of sensor units is available and that is dependent on the control input and the input module present. The Display Units are the same as the set point units. The units are the same for each input (A and B).

4.8.2 Display Sensor Selection - The $F1C_1$ Command

This command selects the sensor input to be displayed independent of the input selected for control.

4.9 The A and B SENSOR ID Information- The AC_1C_2 and BC_1C_2 Commands

The information for these commands is sent to the 805 to set the functional parameters as described in Table 3-1, 3-4 and 4-6.

Table 4-4. 805 Listener Program Code Summary
Instrument Setup, Selection of Set Point Units, Display Sensor and Setting SENSOR ID

Program Code	Functional Description
ZN_1[a]	Selects IEEE EOI status. Forms of the command are Z0 and Z1. When N_1 is: EOI Status is: 0 — EOI line is set/accepted on last character input or output. 1 — EOI line is not set on last character output or acknowledged on input.
MN_1	Selects Remote Interface mode. Command forms are M0, M1, M2 When N_1 is: Mode is: 0 — Local 1 — Remote 2 — Remote with Local Lockout
TN_1	Changes terminating characters (when IEEE Address Switch #1 is CLOSED [1]). Forms of the command are T0, T1, T2 and T3. When N_1 is: Terminators are:[b] 0 — (CR)(END[c] ^ LF) [also with Switch OPEN] 1 — (LF)(END ^ CR) [default, unless changed] 2 — (END ^ LF) 3 — (END ^ DAB[d])
C	"Clear" command, returns unit to power up state (Restart).
$F0C_1$[e]	Function 0 - Select Set Point (Control) Units. Forms of the command for temperature in kelvin, celsius and fahrenheit are F0K, F0C and F0F, respectively. For Sensor Units in volts or ohms, the command is F0V or F0R.
$F1C_1$	Function 1 - Select Display Sensor (Input A or Input B). Forms of the command are F1A and F1B.
AC_1C_2*	Input SENSOR A ID. C_1C_2 are 00 thru FF. Command forms are A00 thru AFF (see Figure 3-3 and Table 4-6 for command usage.
BC_1C_2*	Input SENSOR B ID. C_1C_2 are 00 thru FF. Command forms are B00 thru BFF (see Figure 3-3 and Table 4-6 for command usage.

a) N_i corresponds to a numeric value (0 - 9).
b) The AND symbol (^) is used to indicate messages sent concurrently.
c) END = EOI
d) DAB = last data byte
e) C_i corresponds to an alphanumeric.
* When the 805 is sent back to LOCAL, this data is lost, since the instrument will now read the settings of the hardware SENSOR ID's of A and B.

Table 4-5. 805 Program Code Summary, Cont'd.
Control Commands and Output Statement Request

S or SN_1 or $SN_1.N_2$ or SN_1N_2 or $SN_1N_2.N_3$ or $SN_1N_2N_3.N_4$ or $SN_1.N_2N_3$ etc. or ( )SN_1 or ( )$SN_1.N_2$ or ( )$SN_1N_2.N_3$ etc.

Set Point Input. The decimal point is "FREE FIELD" and its allowable position depends on the control units. Limits are

Units	Range
K	0 Through 999.9
C,F	-999.9 Through 999.9
V	0 (0.000) Through 9.999
R	0 Through 999.9

The Set Point is limited based on input card and Sensor. Lower limit is 0 K (-273.1 °C or -459.6 °F).

Input Module	Sensor Type	Upper Set Point Limit K	°C	°F	Sensor Units
-3(Std)	DT-470, DT-500,	324.9	51.7	125.1	2.999 volts
-6	TG-120	"	"	"	6.554 volts
-3	DT-470	474.9	201.7	395.1	2.999 volts
-P2	PT-100 Series	799.9	526.7	980.1	299.9 ohms
-P3	PT-1000 Series	"	"	"	2999. ohms
-R1	Rhodium-iron	"	"	"	99.99 ohms

P* or $PN_1.N_2$ or PN_1N_2.

Proportional (GAIN). N_1N_2 is 0.0 (OFF) through 99 (three characters including the decimal point). Forms of the command are P, P0, P0.0 through P99.

I* or $IN_1.N2$. or IN_1N2.

Integral (RESET). N_1N_2 is 0.0 (OFF) through 99 (three characters including the decimal point). Forms of the command are I, I0, I0.0 through I99.

R* or RN_1

Heater Range. N_1 is 0 through 9. Forms of the command are R0 through R9. R1, R2 and R6 thru R9 are equivalent to R0.

N_1	Range	Heater Current
0	OFF	0
3	LO	100 mA
4	MED	330 mA
5	HI	1 A

WC_1^e

Output Statement Format. Forms of the command are:

W0	Display and Control Data
W1	A and B Input Information
W2	Interface Status
W3	Control Data (Gain, Reset, etc.)
WS	Display Data
WP	Set Point Data
WI	Input Module and Option Card Data

* The command "SPIR" or any combination without a value following the letter sets the chosen parameters to 0, e.g., "SP" sets the set point and gain to 0.

The Table below defines the AC_1C_2 and BC_1C_2 definitions as independent functions. If multiple functions are to be selected, the character equivalents are additive (see examples below, which are given as SENSOR A ID's - they pertain to SENSOR B ID's as well).

A30 - Disable digital filtering and select Sensor Curve 03 to be used to determine temperature.

A32 - Enable digital filtering and select Sensor Curve 03 to be used to determine temperature.

Table 4-6. Remote Interface Input of the A and B SENSOR ID

C_1C_2 - from AC_1C_2 or BC_1C_2	Functional Description
01	Reserved
02	Digital Filtering On
04	Reserved
00 thru F0	Select Sensor Curve number 00 (0) thru 15 (F)

4.10 THE CONTROL COMMANDS (See Table 4-5)

4.10.1 The Set Point Value - The S Command

The set point is sent from the controller to the 805 in a free field format of which examples are given in Table 4-7. Note that the sign only has to be present if negative and the temperature is celsius or fahrenheit. Although the limits on the input range above the values possible for the various sensors, the set point is limited by the input module present as shown in the table. Note that the temperature limit can be different for the DT-470 depending on whether curve number 2 (324.9K) or curve number 4 (374.9K) has been selected. If a number above the limitation for the card is entered, the set point is set to the upper temperature limit. Also note that an S sent by itself to the 805 sets the set point to 0 kelvin (or its equivalent in the units chosen) which shuts down the output stage of the temperature controller.

4.10.2 Setting the GAIN - The P Command

The gain is a multiplier between 0.1 and 99., a range of 1000 with 0.0 or 0 as OFF. The format is free field with examples of the command being P0, P0.0, P.1, P0.1, P9, P9., P9.0, P99, P99., etc. The string P987.12 will be interpreted as P7.1, i.e., one character before and the first character after the decimal point will be retained. A P transmitted by itself is equivalent to P0 or P0.0.

4.10.3 Setting the RESET (Integral) - The I Command

The reset is set from 0.01 through 9.9 beats/second. Like the gain command (4-60,61), it is free field with the same characteristics and format.

4.10.4 Heater Range - The R Command

The heater range can be changed over the bus with the RN_1 command. R1, R2 and R6 and up are equivalent to the R0 command (see Table 4-5).

4.10.5 Note: The Return to LOCAL

Although the Set Point, Gain, Reset and Sensor ID's can be changed over the IEEE Bus, when the 805 returns to Local, these settings are read and updated from the front panel (set point, gain and reset) and the SENSOR ID switches on the back panel.

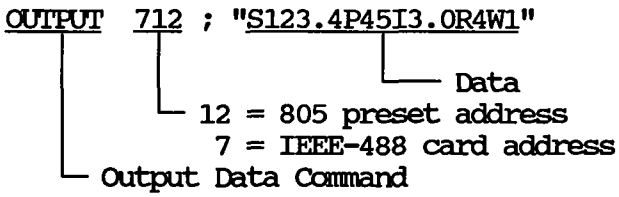
4.11 Output Statement Request - The WC_1 Command (Table 4-5)

The Output Statement Request Command is sent by the controller to the 805 to tell the 805 what data to output when a data output is requested. These data formats are described in detail in Tables 4-7 and 4-8 as well as the adjoining text associated with those tables.

4.12 PROGRAM EXAMPLES

The following example in HP Basic sets the set point to 123.4 K, the gain to 45, the reset (integral) to 30, the heater range to MED and requests the

output statement to be sent to be W1.



4-74. If the user were to monitor the IEEE-488 Bus when either of the above computers sent its command string over the Bus, they would observe the following IEEE-488 Format.

Command Mode	Data Mode
? U ,	S123.4P45I30R4W1(CR)(LF)

The Universal Unlisten Command (?) is sent so that no other instruments on the Bus will eavesdrop on the Bus and assume that the data being sent is for their attention. The controller's Talk Address (U) is sent to unaddress any existing talker. Note that the controller could have designated another instrument as the talker. Therefore, to keep the format consistent, it must send a Talk Address even when the controller is going to be that talker. The 805's Listen Address (,) must be sent to tell which instrument on the Bus is to receive the Data String. Note that [TERMl] [TERM2] have been indicated to be CR LF (carriage return, line feed); these are the correct terminators for the HP computer example.

Note that the string "P45I30P40" would result in a gain of 40 and an integral value of 30, i.e., only the last value sent over the bus for that program code will be entered after the appropriate terminators have been sent over the bus.

4.12.1 Output Data Statements

The 805's Output Data Statements are given in Tables 4-7 and 4-8.

4.12.2 The "W0" Data String (Table 4-7)

The following example in HP Basic illustrate the commands associated with obtaining output data from the 805. The addition of the M0 command returns the instrument to front panel control where it stays even when data is requested from the 805 by the HP computer.

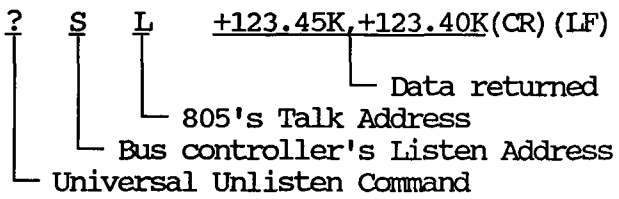
```
10   DIM A$ [19]
20   OUTPUT  712; "W0M0"
30   ENTER   712; A$
```

The following information is sent across the bus in the IEEE-488 format as a result of the above software commands.

Command mode sent:

? U , W 0 (CR)(LF)

Data returned:



The data above indicates that the display temperature is 123.45K and that the set point is 123.40K.

4.12.3 The "W1" Data String (Table 4-7)

If instead of W0, W1 had been requested, the data string would have the following format:

A,B,K,K,A20,02,B42,04(CR)(LF)

The above string indicates that the Display Sensor is A; the Control Sensor is B; both are in kelvin temperature units; the SENSOR A ID indicating that the Digital Filtering is Off and the Curve selected is number 2; the curve being used for INPUT A is 2; the SENSOR B ID indicates that Digital Filtering for this channel is On and the curve assigned is 4; the curve being used is also 4. Both channels are using Curve 10, the difference is that INPUT A is set for an upper limit of 325K and INPUT B is set with an upper limit of 475K.

4.12.4 The "W2" Data String (Table 4-7)

For the case of W2, the data string would have the following format:

Z0,M2,T1[TERMl][TERM2]

where the Z0, M2 and T1 are defined in Table 4-4.

4.12.5 The "W3" Data String (Table 4-7)

The settings for the gain, reset, heater range as well as the instantaneous % of Heater Power can be transmitted from the 805 with the "W3" command.

4.12.6 The "WS" and "WP" Data Strings (Table 4-8)

These two commands give the same information as the "W0" command; the "WS" command giving the Display Sensor reading while the "WP" command results in the set point value.

4.12.7 The "WI" Data String (Table 4-8)

This Data String gives the modules present (d3, d6, P2, P3 or R1) in Input A and B, whether the analog option is present and the interface option, if present. A typical data string would be:

```
A-d3,B-P2,1-8055,2-8054[TERM1][TERM2]
```

which indicates a standard 3 volt input for Input A; a 100 ohm platinum input for Input B; a linear analog option in Option Slot 1 and a IEEE-488 option in Option Slot 2.

4.13 SAMPLE PROGRAMMING

4.13.1 HP86B Keyboard Interactive Program

The following program for the HP86B is an interactive program with the keyboard of the computer. For example, when the user sees the prompt on the screen and types in a valid 805 command such as "W0", the program will result in the display of the 805 response on the screen.

```
10   REM Set IEEE Address to 12
20   REM Address Switch 1 OPEN(0)
      to get (CR)(LF)
30 REM This program allows the user
to communicate with the 805, inter-
actively from the computer keyboard
40   DIM A$[100]
50 INPUT B$ ! INPUT KEYBOARD COMMAND
60 OUTPUT 712 ;B$ ! SEND COMMAND TO 805
70  ENTER 712 ; A$ ! RECEIVE ANSWER
80   DISP A$ ! DISPLAY ANSWER
90   GOTO 50
100 END
```

4.13.2 National Instruments IBM Example

The following is the same program written for the National Instruments GPIP-PC2 IEEE-488 Card for IBM PCs and Compatibles.

```
10   CLEAR    ,60969 ! BASIC DECLARATIONS
20   IBINIT1 = 60969 !
30   IBINIT2 = IBINIT1 + 3
40   BLOAD "bib.m",IBINIT1
50 CALL IBINIT1(IBFIND,IBTRG,IBCLR,IBPCT,IBSIC,IBLOC,IBPPC,IBBNA,IBONL,
IBRSC,IBSRE,IBRSV,IPPAD,IBSAD,IBIST,IBDMA,IBEOS,IBTMO,IBEOT,IBRDF,IBWRTF)
60 CALL IBINT2(IBGTS,IBCAC,IBWAIT,IBPOKE,IBWRT,IBWRTA,IBCMD,IBCMDA,IBRD,IBRDA,
IBSTOP,IBRPP,IBRSP,IBDIAG,IBXTRC,IBRDI,IBWRTI,IBRDIA,IBWRTIA,IBSTA%,IBERR%,IBCNT%)
70 PRINT "MAKE SURE CAPSLOCK IS ON" ! 805 recognizes only capital letters
80   TEMP$="805" ! 805 is IEEE address label set up when running IBCONF
90 CALL IBFIND(TEMP$,TEMP%)! Required command to address 805
100 A$=SPACE$(255)! 255 is largest data transfer allowed by the IBM format
110  INPUT B$     ! Entered from keyboard while running
120  B$=B$+CHR$(13)+CHR$(10)! Add CR and LF to command
130 CALL IBWRT(TEMP%,B$)! Send command to 805
140 CALL IBRD(TEMP%,A$)! ENTER from 805 (SEE NOTE BELOW)
150  PRINT A$     ! Display received information on screen
160 A$=SPACE$(255)! Clear A$
170  GOTO 110
180  END
190 REM The 805 will return the data requested, but if the command input does 200 REM
not request new information, the 805 will give the information last requested.
```

Table 4-7. 805 Output Talker Data Statements

Command	Output Data Statement
W0	Display Sensor and Set Point Data ( )$N_1N_2N_3$(.)N_4N_5(K)(,)( )$N_6N_7N_8$(.)N_9N_{10}(K)[TERM1][TERM2] 17 characters plus up to 2 terminators where: (.) may vary in position dependent on units and temperature. ( )N_1-N_5( ) is the Sign, Display Sensor reading and units. ( )N_6-N_{10}( ) is the sign, set point and units. Examples of the Display reading are (±)$N_1N_2N_3$(.)N_4N_5(F), (±)$N_1N_2N_3$(.)N_4N_5(C), ( )$N_1N_2N_3$(.)N_4N_5(R) or ( )N_1(.)$N_2N_3N_4N_5$(V). Note that all are "free field" where the units are K, C, F, V or R and the sign ( ) may be (±) for the fahrenheit and celsius scales.
W1	A and B Input Information C_1(,)C_2(,)C_3(,)C_4(,A)C_5C_6(,)N_1N_2(,B)C_7C_8(,)N_3N_4[TERM1][TERM2] 21 characters plus up to 2 terminators where: C_1 is the Display Sensor A or B. C_2 is the Control Sensor A or B. C_3 is the Set Point Units (K, C, F, V or R). C_4 is the Display Units (K, C, F, V or R). C_5C_6 is the A ID (00 through FF). N_1N_2 is the A curve number (00 through 30). C_7C_8 is the B ID (00 through FF). N_3N_4 is the B Curve Number (00 through 30).
W2	Interface Status (Z)N_1(,)(M)N_2(,)(T)N_3[TERM1][TERM2] 8 Characters plus up to 2 Terminators where: N_1 is EOI status (see Table 4-3). N_2 is Mode status (see Table 4-3). N_3 is Terminator status (see Table 4-3).
W3	Control Data (Gain, Reset, Heater Range, % of Heater Power.) $N_1N_2N_3$(,)$N_4N_5N_6$(,)N_7(,)$N_8N_9N_{10}$[TERM1][TERM2] 13 characters plus up to 2 terminators where: $N_1N_2N_3$ is the Gain Value $N_4N_5N_6$ is the Reset Value N_7 is the Heater Range $N_8N_9N_{10}$ is the % of Heater Power or Current out.

Table 4-8. 805 Output Talker Data Statements

Command	Output
WS	Display Sensor Data ( )$N_1N_2N_3$(.)N_4N_5(K)[TERM1][TERM2] 8 Characters plus up to 2 Terminators where the N_1-N_5 variations are the same as for W0.
WP	Set Point Data ( )$N_6N_7N_8$(.)N_9N_{10}[TERM1][TERM2] 8 Characters plus up to 2 terminators where the N_6-N_{10} variations are the same as for W0.
WI	Input and Option Card Data (A-)C_1C_2(,B-)C_3C_4(,1-)$C_5C_6C_7C_8$(,2-)$C_9C_{10}C_{11}C_{12}$[TERM1][TERM2] 23 Characters plus up to 2 Terminators where: C_1C_2 is the A Input Module. C_3C_4 is the B Input Module. C_5-C_8 is the Linear Analog Option (8055) Present. C_9-C_{12} is the 8053 or 8054 Interface Option Present.

4.13.3 HP Computer Example of 805 Commands

The following program is for the HP86B and exercises the various bus commands.

```
10 REM Set IEEE Address to 12
20 REM Address Switch 1 OPEN (0) to get
(CR)(LF)
30 DIM A$[25]    ! For longest string
40 OUTPUT 712;"W0"  ! Note W0
50 ENTER 712;A$   ! Ask for string W0
60 DISP "W0 = ";A$ ! Display string W0
70 DISP "Display Sensor =";A$[1,8]
75 REM Display Sensor reading
80 DISP "Set Point =";A$[10,17]
85 REM Display Set Point reading
90 DISP          ! Space a Line
100 OUTPUT 712;"W1" ! A and B Input
110 ENTER 712;A$  ! Ask for string W1
120 DISP "W1 = ";A$ ! Display string W1
130 DISP
140 OUTPUT 712;"W2" ! Interface Status
150 ENTER 712;A$  ! Ask for string W2
160 DISP "W2 = ";A$ ! Display string W2
170 DISP
180 OUTPUT 712;"W3"
185 REM Control Data (Gain, Reset, etc.)
190 ENTER 720;A$  ! Ask for string W3
200 DISP "W3 = ";A$! Display string W3
210 DISP "Gain =";A$[1,3] ! Display Gain setting
220 DISP "Reset =";A$[5,7]! Display Reset setting
230 DISP "Heater Range =";A$[9]! Heater Range
240 DISP "% Power =";A$[11,13] ! % Power
250 DISP
260 OUTPUT 712;"WS"! Set for WS
270 ENTER 712;A$  ! Ask for string WS
280 DISP "WS = ";A$! Display string WS
290 DISP
300 OUTPUT 712;"WP"! Set Point
310 ENTER 720;A$  ! Ask for string WP
320 DISP "WP = ";A$! Display string WP
330 DISP
340 OUTPUT 712;"WI"! Set for WI
350 ENTER 712;A$  ! Ask for string WI
360 DISP "WI = ";A$! Display string WI
370 END
```

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SECTION V

MAINTENANCE

5.1 INTRODUCTION

This section contains information necessary to maintain the Model 805. General maintenance, fuse replacement, line voltage selection and performance testing is contained in this section.

5.2 GENERAL MAINTENANCE

Clean the 805 periodically to remove dust, grease and other contaminants. Use the following procedure:

1. Clean the front and back panels and case with a soft cloth dampened with a mild detergent and water solution. Caution: **DO NOT** use aromatic hydrocarbons or chlorinated solvents to clean the 805. They may react with the plastic materials used in the unit or the silk screen printing on the back panel.

2. Clean the surface of the printed circuit boards (PCB) using clean, dry air at low pressure. If grease is encountered, spray with Freon T.F. degreaser and remove grime with dry, low-pressure air.

5.3 FUSE REPLACEMENT

The line fuse is accessible from the rear of the 805. Use the following procedure to check and/or replace the fuse:

WARNING

To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before replacing the fuse.

1. Set the POWER switch to OFF and disconnect the power cord from the unit. The fuse compartment is located just above the power connector.

2. Open the fuse compartment by prying open the cover with a small screw driver.

3. Remove the right fuse holder by sliding it out of its position with the aid of the small screw driver.

CAUTION

For continued protection against fire hazard, replace only with the same type and rating of fuse as specified for the line voltage selected.

4. Replace the fuse rated per Table 2-1.

5. Replace fuse holder, close fuse compartment and connect power cord.

5.4 LINE VOLTAGE SELECTION

The rear-panel, three-pronged line power connector permits the 805 to be connected to 100, 120, 220, or 240 VAC line voltages. Use the following procedure to change the line voltage:

WARNING

To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before changing the line voltage selection.

1. Pull fuse compartment cover using the procedure found in Section 5-5.

2. Remove voltage selector wheel and insert with the proper voltage facing out. Note that the wheel can only be inserted with the writing read right side up.

3. Install the proper fuse as outlined in Section 5-5.

5.5 PERFORMANCE VERIFICATION

5.5.1 Performance Verification Connector

A performance verification connector for the rear panel SENSORS/MONITORS connector J1 to simulate diode sensor inputs is required for the performance verification of the 805. The test connector can be made by taking the solder pin plug supplied with the 805 and configuring two resistors to simulate the Input A and Input B sensors in the two-wire configuration as shown in Figure 2-2. A 100K ohm, 0.01% resistor is used in the performance test. This test connector can be used with an 805 with a diode input configuration **only**.

5.5.2 Performance Verification Procedure

The performance test is designed to verify the overall operation of the 805 and can be used as a periodic maintenance check. The following equipment is used in the test.

1. Digital Voltmeter/Multimeter (DVM) - 4 1/2 digit resolution or better.

2. Performance Verification Connector - fabricated per Section 5-10.

Complete the following set-up procedure for the performance verification test:

1. Connect the DVM across the 100K resistor of Input A of the test connector.

2. Connect the 805 to line power and turn the unit ON. Verify that the 805 initializes to the proper POWER-ON state as defined in Section 3.6.1.

The following procedure is used to manually test the overall operation of an 805.

Note: The unit should be allowed a one-hour warm-up time to achieve rated specifications:

1. The DVM across the test resistor should read 1.0000 +/- 100 uV dc provided the 100K resistor is exact in value. This is a check of the constant current source of 10 microamperes.

2. Select Input A for the display SENSOR. The voltage which will be displayed should be 1.0000 volts. The kelvin temperature which will be displayed depends on the curve selected by the A SENSOR ID. The choices are as follows:

Curve No.	Switch 45678	Temperature Displayed,K	Description
00	00000	71.8	DRC-D
01	00001	71.4	DRC-E1
02	00010	87.8	CRV 10
03	00011	N/A	DIN-PT
04	00100	87.8	CRV 10

3. Verify that the units can be changed by pushing in the UNITS key to change the units in sequence; K, V, F, C, K, etc. (Note: the unit goes to V for a diode configuration or Ω for a resistance module.

4. Change to INPUT B. Repeat the above process by verifying the current source and the A/D settings for this input.

5.6 CALIBRATION

5.6.1 Input Card Calibration

Calibrate each input module as specified in Section VI for that module.

5.6.2 Current Source Calibration

Connect the voltage leads of the DVM across the 100K test resistor for Input A and adjust the A-I trimpot until the voltage across the resistor is exactly 1.0000 volts. Repeat this procedure for Input B.

5.6.3 A/D Converter Calibration

Select the 00 curve for the SENSOR A ID and the A input for display with kelvin units. Connect the voltage standard across the V+ and V- pins of the A input on the J! SENSORS/MONITORS Connector. Set the Voltage Standard to 0.84606 volts and ad-

just the trimpot marked A/D on the microprocessor card until the display reads 130.0 kelvin.

If a Voltage Standard is not available, then connect the 100K precision resistor across the I+, V+ to the V-, I- pins of the A input and adjust the A/D trimpot until the display reads 1.000 volts, or for a more accurate calibration, select a kelvin display and adjust the display until it reads 71.81 kelvin.

5.6.4 Set Point Calibration

Place the ground of the DVM into TP1 and the positive lead into TP2. Change the display units to voltage. Set the set point to 0 volts and adjust SP ZERO ADJ until the DVM reads 0.0000 volts. Set the set point to 2.200 volts and adjust the SP SPAN ADJ until the DVM reads 2.2000 volts. Repeat until neither reading changes.

5.6.5 Heater Meter Calibration

Connect a load resistor of appropriate wattage in place of the load heater. Set up the 805 so that not more than 50% heater power is set. Place the low lead of the DVM into TP6, the high lead into TP5 and adjust PWR V- ADJ until the DVM reads 1.000 volts. Then place the low lead of the DVM into TP8, the high lead into TP7 and adjust PWR VREF ADJ until theDVM reads 1.000 volts.

5.6.6 Output Current Adjust

Place the high lead of the DVM into TP5, the low lead into TP9 and adjust PWR V+ ADJ until the DVM reads 1.000 volts.

5.7 TROUBLESHOOTING

Information on troubleshooting the Model 805 controller is contained in the Technical Service Guide for this instrument. This Guide is available from Lake Shore for a nominal charge.

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SECTION VI

OPTION AND ACCESSORY INFORMATION

6.1 INTRODUCTION

This section contains a brief description of the options and accessories available for the Model 805 Temperature Controller. Each Option, Input Module and accessory is listed by part number in Table 6-1.

Table 6-1. Option and Accesories for Model 805 Temperature Controller

PART NUMBER	DESCRIPTION
	OPTION INPUT MODULES
805-6	6 volt conversion for TG-120 Series Diodes
805-P2	100 ohm platinum conversion input module
805-P3	1000 ohm platinum conversion input module
805-R1 input	27 ohm Rh-Fe conversion module
	ACCESSORIES
106-250	Model 805 Connector Kit
RM-3H1	Rack Mounting Kit
RM-3H2	Rack Mounting Kit
8072	IEEE-488 Interface Cable
8271-11	Sensor/Heater Cable
8271-12	Sensor/Heater/Output Cable 25 ohm cartridge heater 50 ohm cartridge heater
	OUTPUT POWER OPTION
W60	60 watt output stage for 25 ohm heater
	OPTION INTERFACE CARDS
8053	RS-232C Interface Card
8054	IEEE-488 Interface Card
8055	Analog Output Card

6.2 OPTION INPUT MODULES

The Option Input Modules are described in Section I, Table 1.1 of this Manual.

6.3 ACCESSORIES

6.3.1 Model 805 Connector Kit

The connector kit for the Model 805 consists of one 24 pin "D" style plug mate to the J1 SENSORS/MONITORS connector (LSCI Stock # 106-250).

6.3.2 RM-3H1/3H2 Rack Mount Kits

The Model 805 can be rack mounted in a standard 19 inch instrument rack using either the RM-3H1 or RM-3H2 Rack Mounting Kits. The RM-3H1 kit mounts one Style L half-rack unit in a height of 3.5 inches. The RM-3H2 mounts two half-rack units in the same space, side-by-side. (Refer to Figure 2-1 for a RM-3H1 installation with handles).

6.3.3 8072 IEEE-488 Interface Cable

The 8072 IEEE-488 interface cable is one meter long and is equipped with double-ended connectors so it may be interconnected in serial or star patterns common in IEEE instrument configurations.

6.3.4 8271-11 Sensor/Heater Cable

The 8271-11 Sensor/Heater Cable is 10 feet (>3 meters) long with a 24 pin D-style locking receptacle with hood and a dual banana plug for power output. Included are four lead connections for two sensors as well as the power output leads. This cable is constructed from six individually shielded twisted pairs and mates to J1, the 24 pin D-style connector and the banana output for power on the back of the Model 805. The

other end of this cable is unterminated and ready for the user to add his system connector.

6.3.5 8271-12 Sensor/Heater/Output Cable

The 8271-12 Sensor/Heater/Output Cable is the same as the 8271-11 Sensor/Heater Cable with the addition of the buffered output of sensor voltage and connections for the optional analog output. Construction is from nine individually shielded twisted pairs.

6.4 OUTPUT POWER OPTION

6.4.1 W60 Output Stage

The W60 output stage for the Model 805 Temperature Controller replaces the standard 25 watt output stage with an output which is rated at greater than 1.5 amperes and up to 40 volts resulting in a maximum power output of approximatelly 60 watts into a 25 ohm load.

6.5 OPTION INTERFACE CARDS

6.5.1 Model 8053 RS-232C Interface

The 8053 RS-232C Interface is designed to be installed in an 805 and provide an interface with an external RS-232C instrument such as a computer, modem or CRT. The interface operates in a half duplex mode (it can transmit and receive information in one direction at a time) and data transmission is asynchronous (each character is bracketed by start and stop bits that separate and synchronize the transmission and receipt of data). The baud rate is switch selectable at 300 or 1200 baud and the interface maintains EIA voltage levels for data transmission.

6.5.2 Model 8054 IEEE-488 Interface

The IEEE-488 interface and its commands are described in Section IV of this manual.

6.5.3 Model 8055 Analog Output Option

The 8055 Analog Output is designed to be installed in a Model 805 and provide an analog voltage output of display sensor temperature in kelvin for the purpose of recording, either with a strip chart recorder or other similar device. The output resolution is 0.1 mV out of 1 volt.

PRECISION CALIBRATION OPTION (8002-05)

FOR THE

MODEL 805

TEMPERATURE CONTROLLER

LakeShore
Measurement and Control Technologies

Lake Shore Cryotronics, Inc.
64 East Walnut St., Westerville, Ohio 43081-2399 USA
Telex: 24-5415 CRYOTRON WTVL
Fax: (614) 891-1392
Telephone: (614) 891-2243

2/91

About the Precision Calibration Option

Lake Shore's Precision Option is a custom-programmed NOVRAM which improves the specified accuracy to 0.1K or better over a given calibration range for DT-470 Series Silicon Diode Sensors. Accuracy for other sensors depends on the sensor type and calibration range.

The Precision Option Table is a piecewise linear interpolation based on the sensor calibration. Optimum break points are determined by an iterative procedure using weighted linear least squares defined by either a maximum number of break points allowed or a maximum allowable error. The break point voltages are the values from the least squares linear equations and will therefore differ from the calibration data. Differences between voltages from the input table and the break point voltage are converted to a corresponding error in temperature by dividing the voltage difference by the sensitivity. Temperature errors by this method will be considerably less than by linear interpolation between calibration data ponts.

A copy of the break point information containing sensor type, sensor serial number, maximum allowable error, break point number, voltage *(or resistance)*, temperature and temperature error is supplied. A second sheet containing only the break point temperatures and voltages is also supplied.

Precision Calibration Option Installation

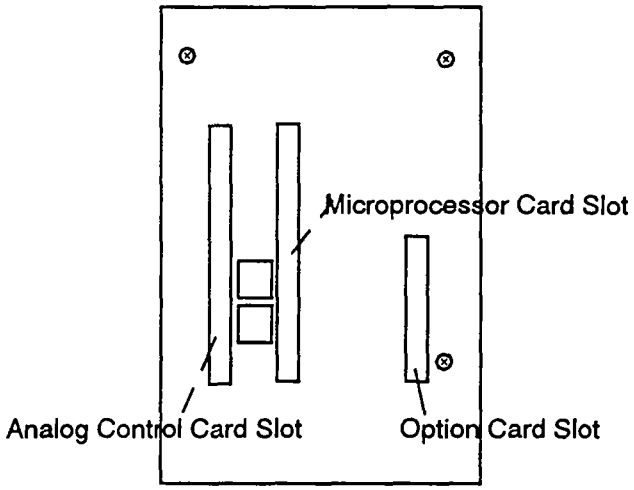
Model 805 Installation (Blue Enclosure)

WARNING	**To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before removing cover.**

1. Set the POWER switch to off and disconnect the power cord from the unit.

2. Remove the two screws which are located along the rear edge of the top panel. Slide the panel toward the rear of the instrument and off. If the top panel will not slide out, use a small flathead screwdriver to pry the top panel lip away from the back panel.

3. The calibration cover will now be seen.



FRONT OF UNIT

4. Remove the three screws which secure the calibration cover to its clips and lift the calibration cover straight up.

5. Carefully remove the microprocessor card by pulling it straight up.

6. The NOVRAM *(precsion option)* should be placed in the socket on the microprocessor card which will be the closest to the front of the unit when the card is replaced. Remove the old NOVRAM by placing a small flat head screw driver between the NOVRAM and its socket. Be sure that pin 1 of the NOVRAM is placed at the top of the card. Pin 1 is indicated by a small circular depression in the top case of the NOVRAM.

7. Carefully replace the microprocessor card by pushing it strainght down into its slot.

8. Note that the calibration cover has plastic posts which restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots and test points are accessible through the calibration cover. Replace the three calibration cover mounting screws

9. Replace the top enclosure and tighten the screws.

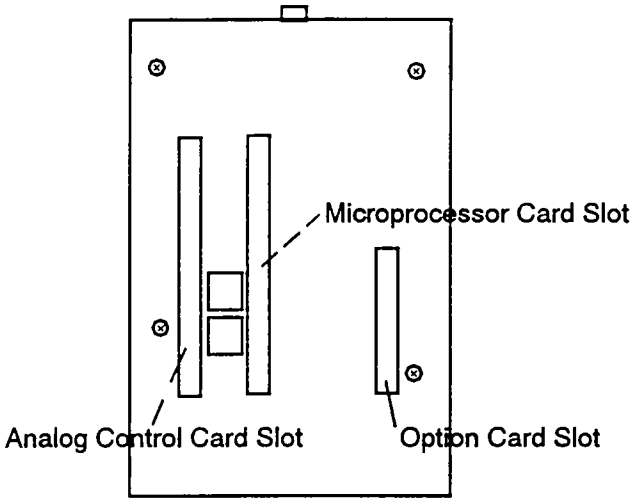
Model 805 Installation (Gray Enclosure)

WARNING	**To prevent shock hazard, turn off the instrument and disconnect it from AC line power and all test equipment before removing cover.**

1. Set the POWER switch to off and disconnect the power cord from the unit.

2. Remove the 6 screws from the sides of the top enclosure half and lift the cover off.

3. The calibration cover will now be seen.



FRONT OF UNIT

4. Remove the four screws which secure the calibration cover to the instrument. Also, remove the screw in the center of the rear panel of the instrument located near the top. Lift the calibration cover straight up to remove.

5. Carefully remove the microprocessor card by pulling it straight up.

6. The NOVRAM *(precsion option)* should be placed in the socket on the microprocessor card which will be the closest to the front of the unit when the card is replaced. Remove the old NOVRAM by placing a small flat head screw driver between the NOVRAM and its socket. Be sure that pin 1 of the NOVRAM is placed at the top of the card. Pin 1 is indicated by a small circular depression in the top case of the NOVRAM.

7. Carefully replace the microprocessor card.

8. Note that the calibration cover has plastic posts which restrict side-to-side movement of the individual cards. Re-align the cards so that their respective adjustment pots and test points are accessible through the calibration cover. Replace the calibration cover mounting screws.

9. Replace the top enclosure and tighten the screws.

REPLACEABLE PARTS LIST - 805 MAIN BOARD

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C1	101-285	1	CAP,ELECT,10000MF,25V	MEP	SM25T10000
C2-5	101-225	4	CAP,ELECT,470MF,35V	PAN	ECEAIVV471S
C25	101-245	1	CAP,ELECT,3300MF,50V	NUC	SM50T3300
C26	101-207	1	CAP,ELECT,10MF,100V	SPRG	30DTE1407
C36,37 39,45,46	101-034	4	CAP,PP,1MF,100V	FDYNE	MPP2X-1.0-100-10
C38	101-025	1	CAP,PP,.33MF,100V	FDYNE	MPP11.33
CR3-5	102-008	3	BRIDGE RECTIFIER	GI	W02M
CR1,2 9-12	102-003	6	DIODE RECTIFIER	MOT	MR501
CR13,14	102-001	2	DIODE RECTIFIER	MOT	1N4006
J1	106-419	1	CONNECTOR (MB TO BP)	3M	3592-6002
JA1	106-143	1	CONNECTOR (MB TO TX1)	MOL	2630-09-74-1061
JA2	106-146	1	CONNECTOR (TX1 TO MB)	MOL	2630-09-74-1091
JB/C	106-427	2	CONNECTOR (DB TO MB)	3M	3593-6002
JE1,F1	106-602	2	CNNCTR (MB TO MDL A/B)	SAMT	SSW-107-01-G-S
JE2,F2	106-603	2	CNNCTR (MB TO MDL A/B)	SAMT	SSW-108-01-G-S
K1-K4	105-323	4	DRY REED RELAY	COTO	3501-05-911
Q1	102-072	1	TRANSISTOR, PNP	MOT	2N3906
S1	105-014	1	POWER SWITCH (2 POLE)	ITT	F-01-2UEE/NE15-1B
S2,3	105-408	2	DIP SWITCH 8 POS	GYH	76SB08
S4	105-404	1	DIP SWITCH 4 POS	GYH	76SB04
SP1-4	105-121	1	4 STATION THUMBWHEEL SW	EECO	4A216056GDA
SL0,1	106-229	2	CONNECTOR (25/50)	EDAC	342-050-520-202
SL2	106-227	1	CONNECTOR (18/36)	EDAC	342-036-520-202
U1,2	102-011	2	REGULATOR, +5V	MOT	MC7805ACT
U3	102-012	1	REGULATOR, +8V		7808CT
U4	102-013	1	REGULATOR, +12V		7812CT
U5	102-014	1	REGULATOR, +15V		7815CT
U6	102-024	1	REGULATOR, -15V		7915CT
U7	102-022	1	REGULATOR, -8V		7908CT
U8,16	104-529	2	IC, PORT EXPANDER	NAT	82C55A-5
U9	104-526	1	IC, KEYBD INTERFACE	NAT	P8279-5
U10,11 30,31	104-089	4	IC, OP AMP	MAX	MAX430CPA
U13	104-310	1	IC, 8 BIT MULTIPLEXER	NAT	DM81LS95AN
U18 32,33	104-210	1	IC, HEX INVERTER, O.C.		7406
U19	102-036	1	REGULATOR,ADJ,1.2-57V	NAT	LM317HVK
U20-22	104-355	3	IC, OPTOCOUPLER	GI	740L6000
U23	104-465	1	IC, A/D CONVERTER	TSC	TSC500CPE
U24,25	102-043	2	VOLTAGE REFERENCE, 6.95V	NAT	LM399H
U26,27	104-005	2	IC, OP AMP		LM308N
U28,29	102-074	2	MOSFET, P CHANNEL	SIL	3N163
W1		1	CABLE (MB TO U1)	LSCI	
XU19	106-571	1	SOCKET, TO-3	AUG	M8080-1G40

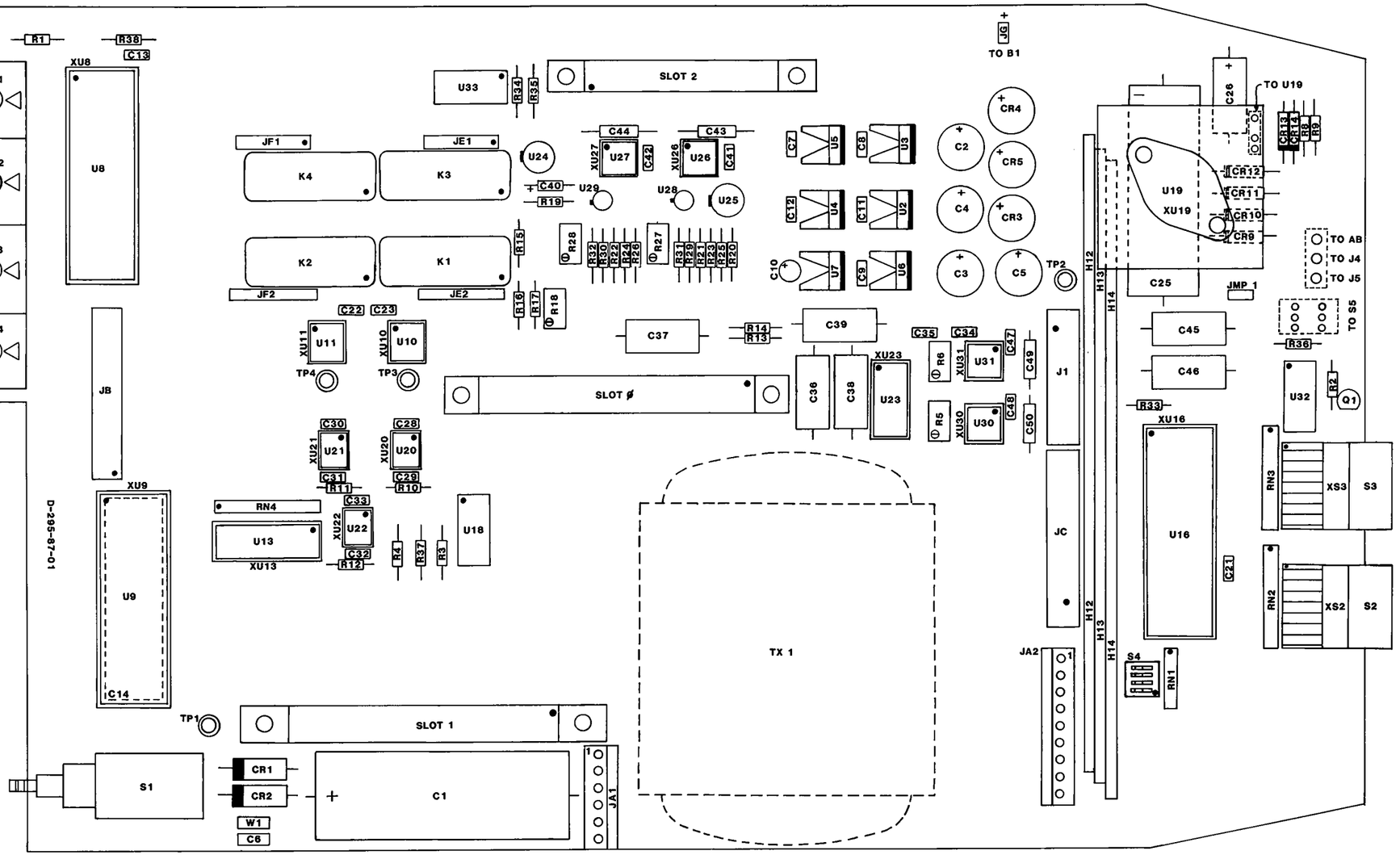


Figure 805-1a. Component Layout – Model 805 Main Board

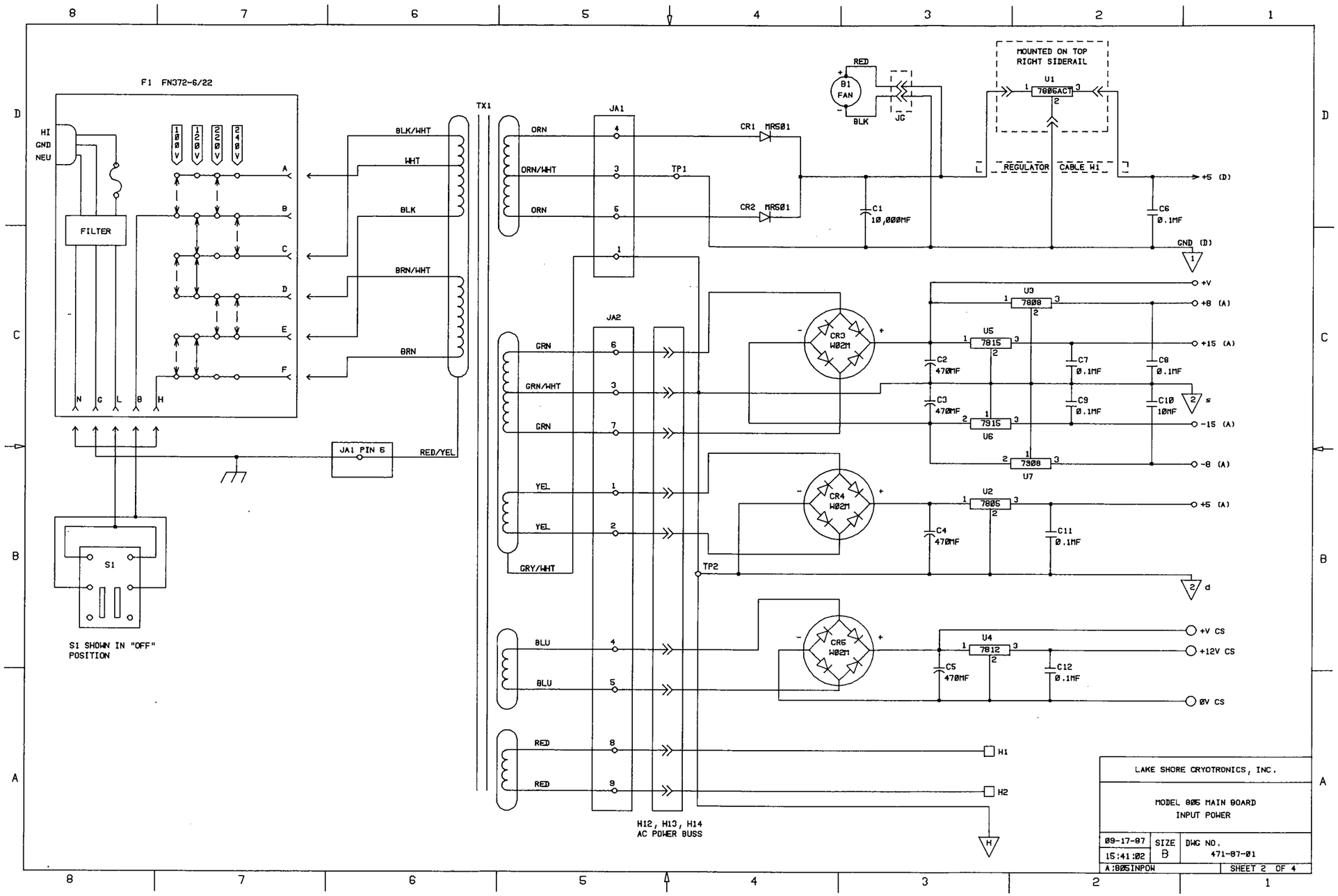


Figure 805-1b. Schematic - Model 805 Main Board #1 (Input Power Supply)

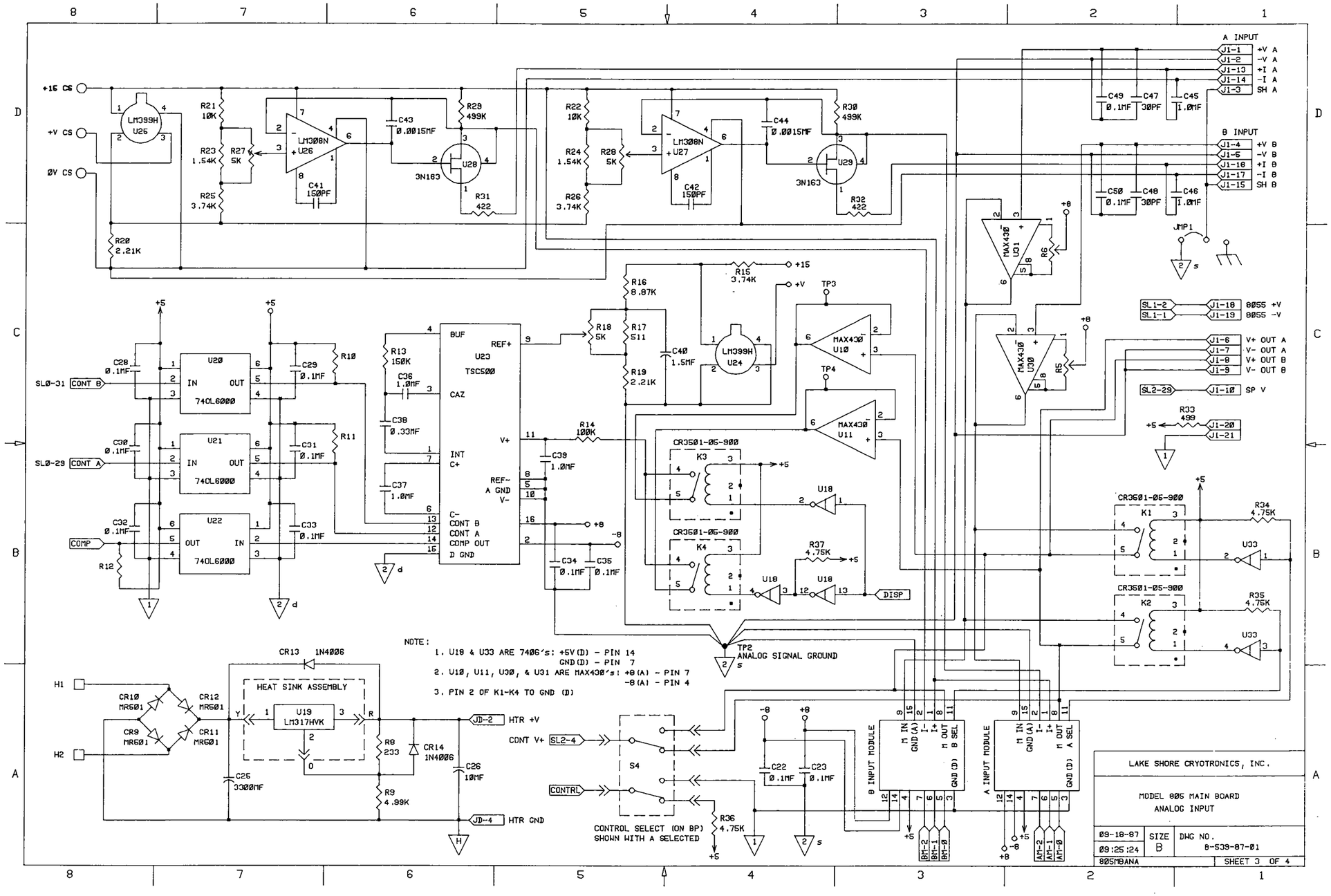


Figure 805-1c. Schematic - Model 805 Main Board #2 (Analog Input and Output Power Supply)

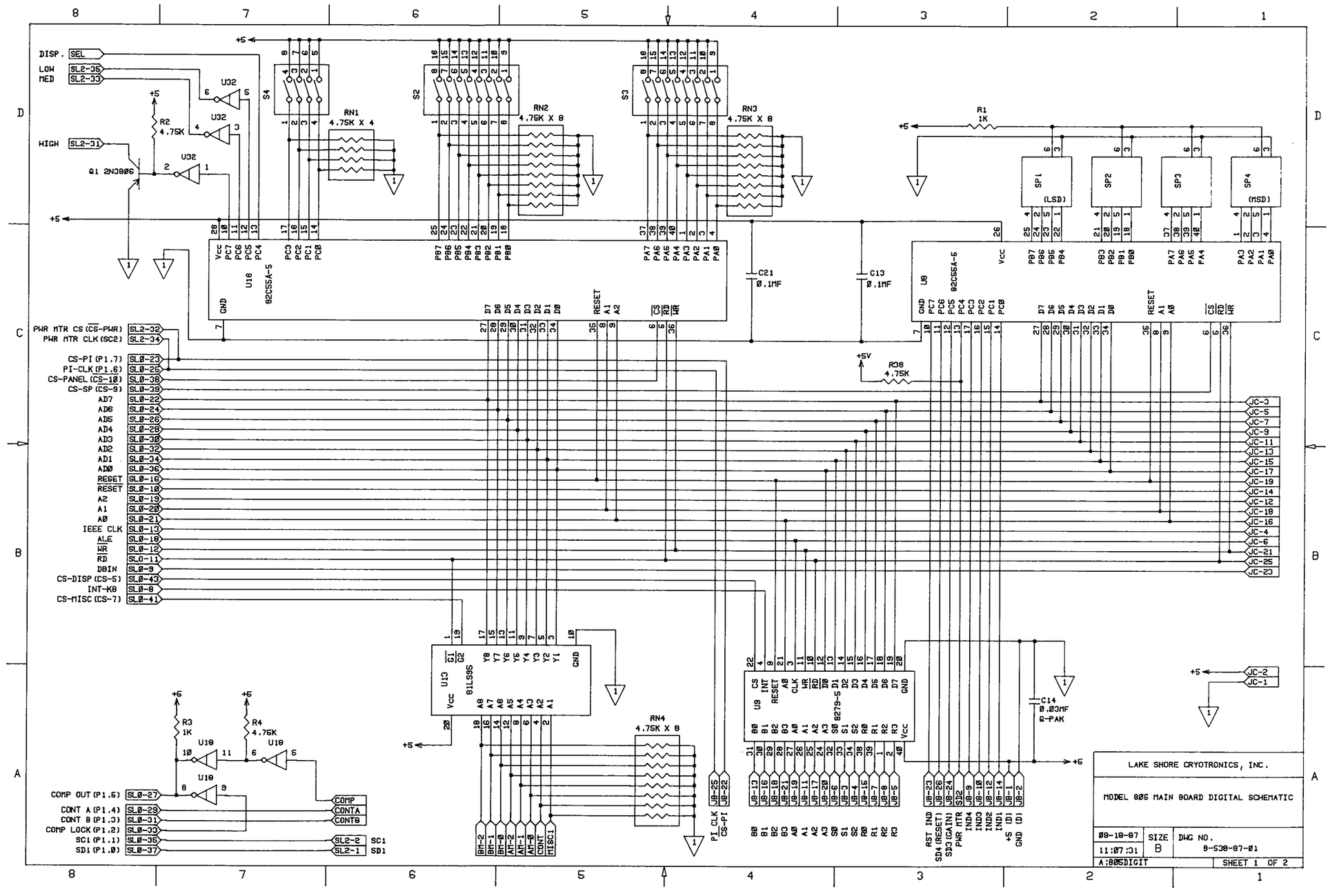


Figure 805-1d. Schematic - Model 805 Main Board #3 (Digital Section)

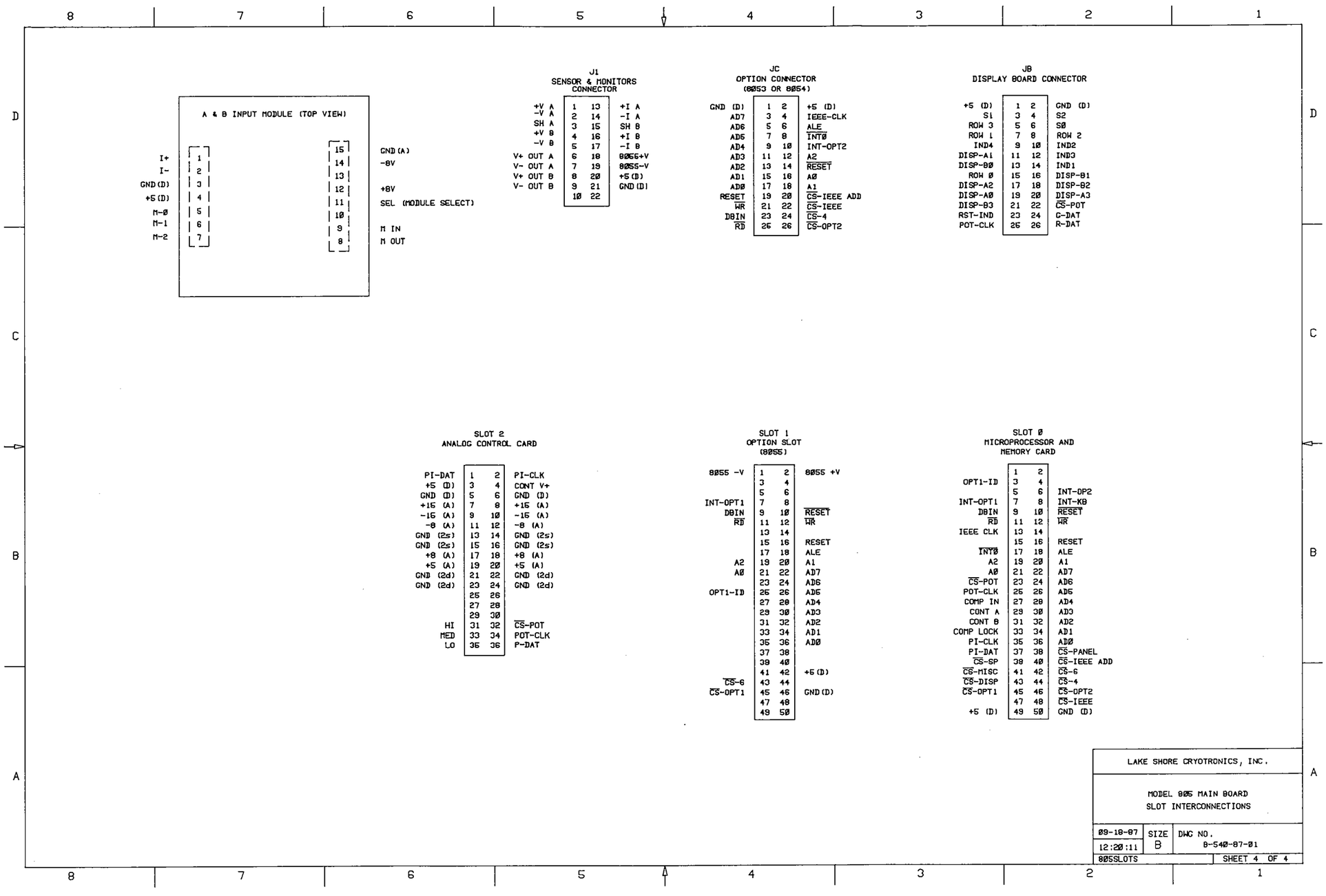
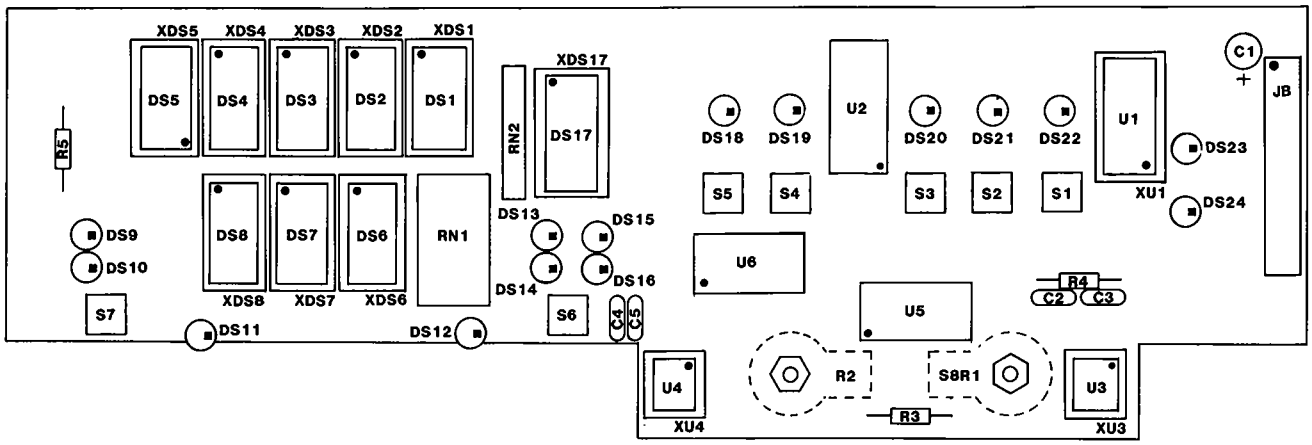


Figure 805-1e. Schematic – Model 805 Main Board #4 (Interconnections)



REPLACEABLE PARTS LIST - 805 DISPLAY BOARD

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
JB		1	CABLE (MB TO DB)	LSCI	
R1/S8	105-146	1	SWITCH POT, 100K,CCW DET	CENT	BA12030018
R2	105-145	1	POT, 100K	CENT	BA12010043
S1-7	105-651	7	SWITCH	ALPS	KEF 10901
U1	104-261	1	IC, 3-8 LINE DECODER		74LS138
U2	104-160	1	IC, TRANSISTOR DRIVER	SPRG	UDN-2585A
U3,4	104-453	2	IC, 8 BIT A/D CONVERTER	NAT	ADC0831CCN
U5,6	104-210	2	IC, INVERTER, O.C.		7406

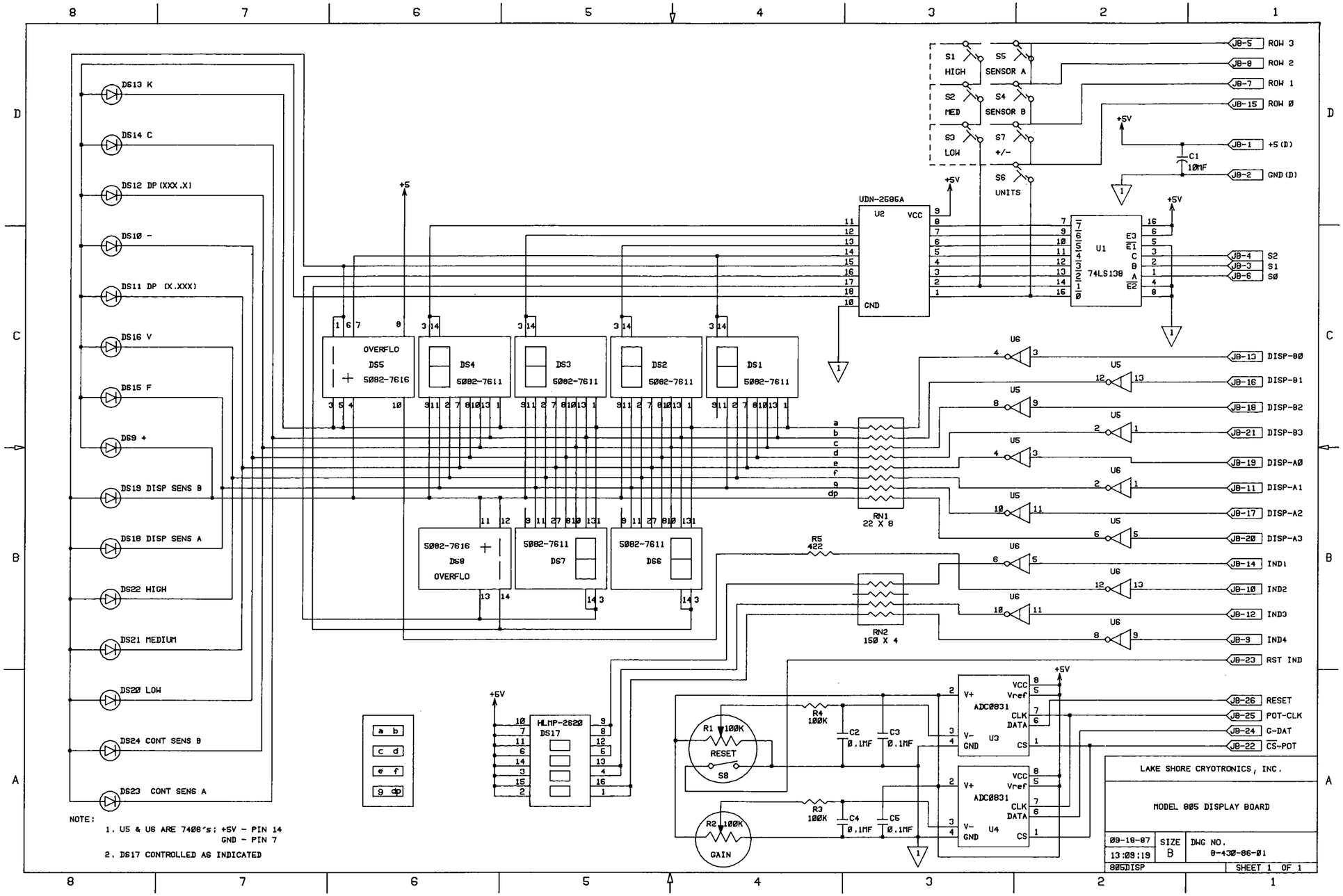
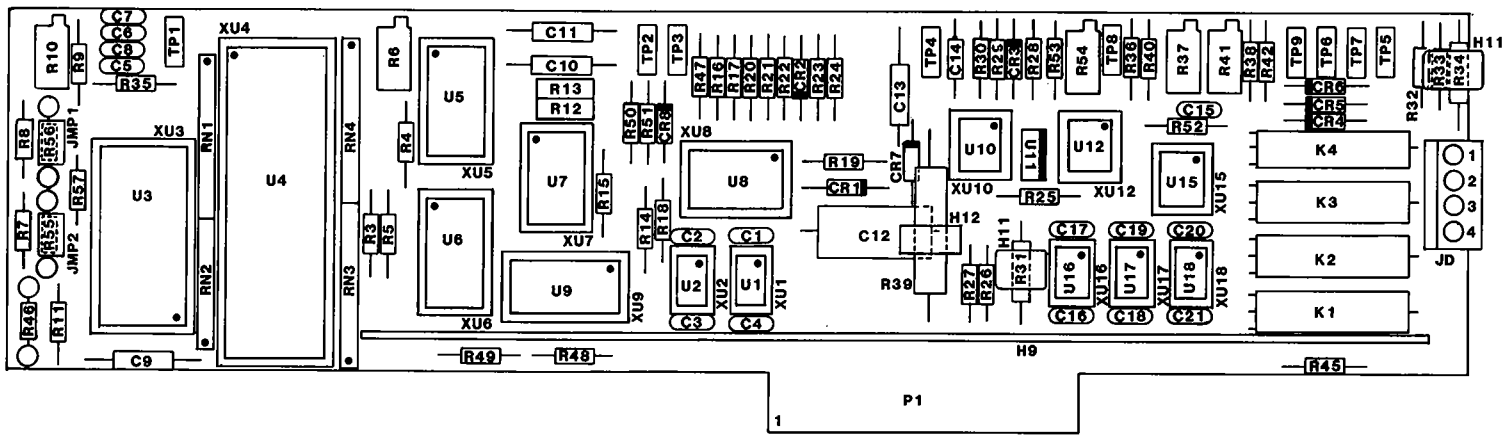


Figure 805-2. Model 805 Display Board



REPLACEABLE PARTS LIST - 805 ANALOG BOARD

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
CR3	102-058	1	DIODE, ZENER, 24V		1N4749A
CR7	102-053	1	DIODE, ZENER, 5.1V		1N751A
JD	106-139	1	4 POST LOCKING HEADER	MOL	2630-09-74-1041
K1-3	105-302	3	RELAY, SPST, 20W	EAC	B1A5AH
K4	105-304	1	RELAY,SPST,50W	EAC	P1A5H
R12,13	113-063	1	RES, PREC, 100K, .01%	LSCI	
R31	103-628	1	RES, WWD, 1.5K, 3W, 1%		
R32	103-495	1	RES, WWD, 9.84, 1/4W, 1%		
R33	103-540	1	RES, WWD, 2.92, 1W, 1%		
R34	103-581	1	RES, WWD, 0.965, 3W, 1%		
R39	103-675	1	RES, WWD, 587, 5W, 1%		
U1,2 16,17	104-355	4	IC, OPTOCOUPLER	GI	740L6000
U3	104-419	1	IC, 16 BIT D/A CONVERTER	BB	DAC703 BH-5
U4	104-162	1	IC, DISPLAY DRIVER	NAT	MM5451
U5	104-408	1	IC, 10 BIT D/A CONVERTER	ISL	AD7533JN
U6	104-404	1	IC, 8 BIT D/A CONVERTER	ISL	AD7523JN
U7,8	104-088	2	IC, OP AMP, QUAD	TSC	TSC914D
U9	104-076	1	IC, DUAL SPDT ANL SWITCH	HAR	HI5043-5
U10	104-022	1	IC, OP AMP, JFET INPUT		LF356N
U11	102-104	1	POWER MOSFET, 90V, P CHAN	SPTX	VN0109N5
U12	104-068	1	IC, DUAL OP AMP MC1741		MC1458PI
U15	104-453	1	IC, 8 BIT A/D CONVERTER	NAT	ADC0831CCN
U18	104-356	1	IC, OPTOCOUPLER	GI	740L6010

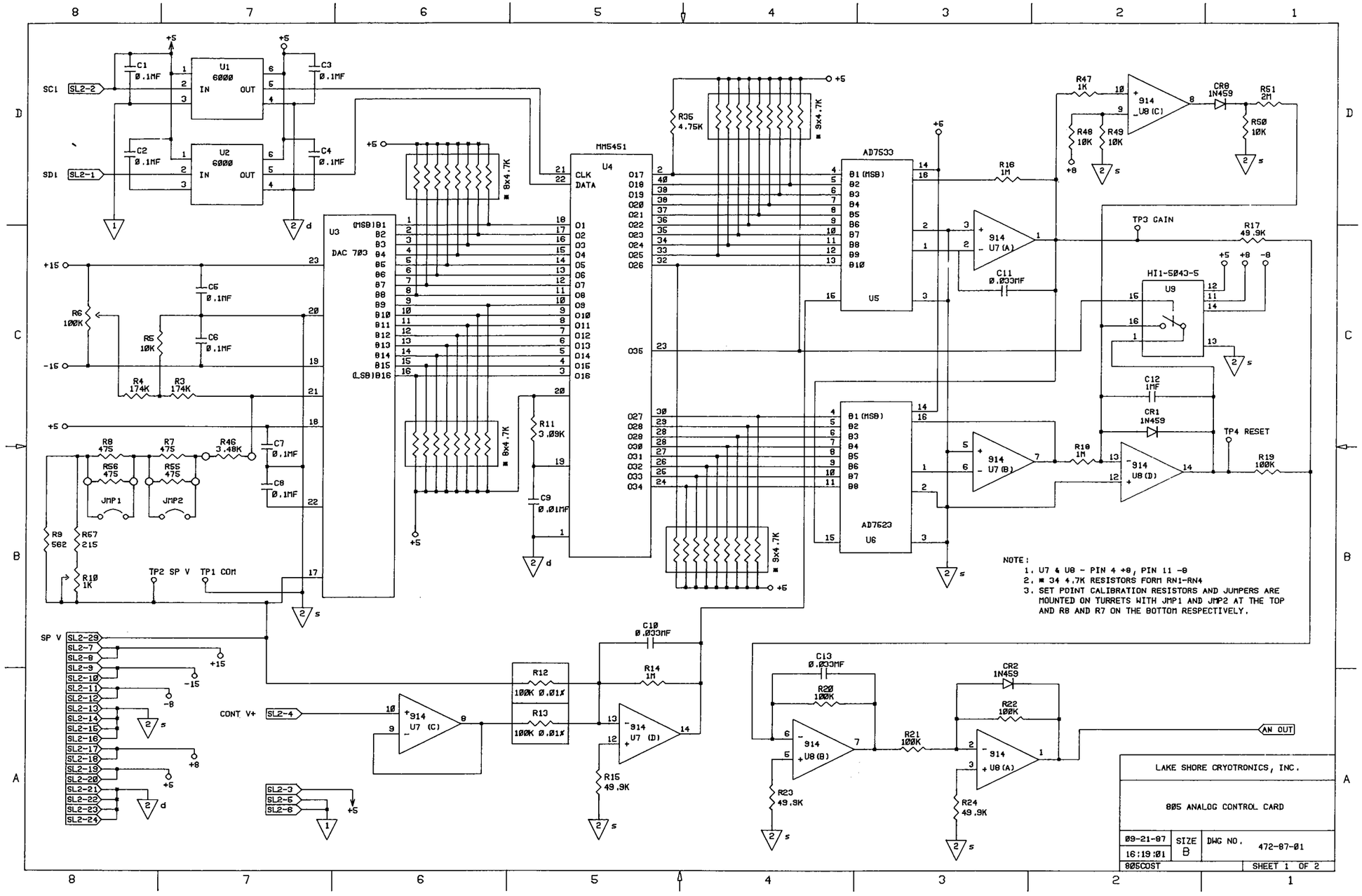
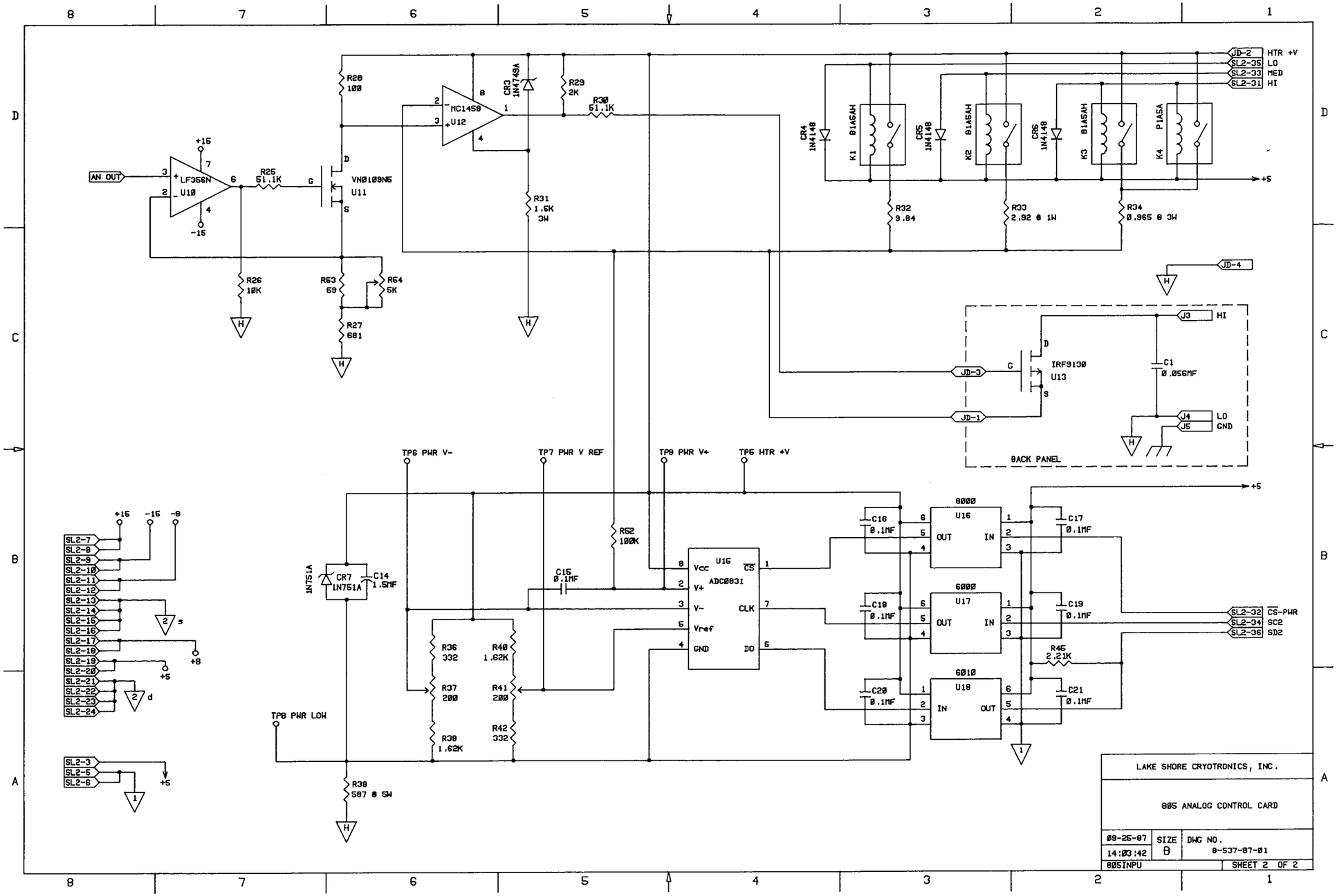
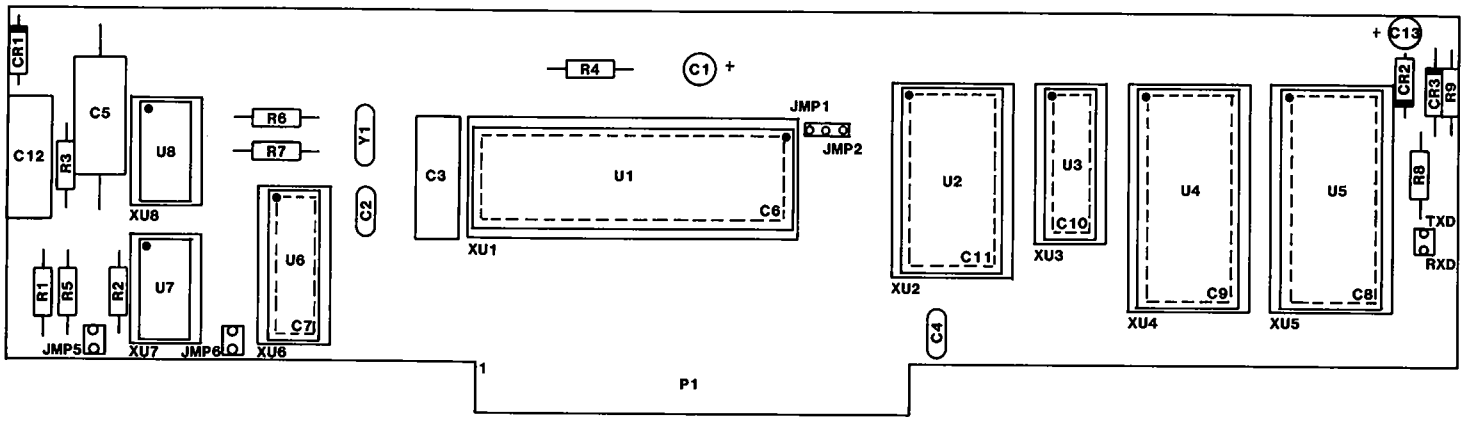


Figure 805-3. Model 805 Analog Board


AN OUT
LF356N
U10
MC1458
U12
VN0109N5
U11
IRF9130
U13
ADC0831
U16
U17
U18
R20 100
R25 51.1K
R26 10K
R27 681
R29 2K
R30 51.1K
R31 1.5K 3W
R32 9.84
R33 2.92 @ 1W
R34 0.965 @ 3W
R36 332
R37 200
R38 1.62K
R40 1.62K
R41 200
R42 332
R45 2.21K
R52 100K
R53 59
R54 5K
C1 0.056MF
C14 1.5MF
C15 0.1MF
C16 0.1MF
C17 0.1MF
C18 0.1MF
C19 0.1MF
C20 0.1MF
C21 0.1MF
CR3 1N4749A
CR4 1N4148
CR5 1N4148
CR6 1N4148
CR7 1N751A
K1 B1A5AH
K2 B1A5AH
K3 B1A5AH
K4 P1A5A
JD-1
JD-2
JD-3
JD-4
HTR +V
LO
MED
HI
+5
J3 HI
J4 LO
J5 GND
BACK PANEL
TP6 PWR V-
TP7 PWR V REF
TP8 PWR LOW
TP9 PWR V+
TP6 HTR +V
+15
-15
-8
+8
SL2-7
SL2-8
SL2-9
SL2-10
SL2-11
SL2-12
SL2-13
SL2-14
SL2-15
SL2-16
SL2-17
SL2-18
SL2-19
SL2-20
SL2-21
SL2-22
SL2-23
SL2-24
SL2-3
SL2-5
SL2-6
SL2-32 CS-PWR
SL2-34 SCI
SL2-36 SDI
LAKE SHORE CRYOTRONICS, INC.
805 ANALOG CONTROL CARD
09-25-87
14:03:42
SIZE B
DWG NO. 8-537-87-01
805INPU
SHEET 2 OF 2



REPLACEABLE PARTS LIST - A9 MICROPROCESSOR CARD

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
C1	101-137	1	CAP,TANT,10MF,10V	SPRG	119D106X0035DB1
C2	101-059	1	CAP,MICA,10PF,500V	CDE	CD15CD100D03
C5	101-018	1	CAP,.047MF,POLY,600V	CDE	WMF6S47
C13	101-144	1	CAP,TANT,33MF,25V	SPRG	199D336X0025EA2
U1	104-511	1	IC,MICROPROCESSOR	INT	P80C31
U2	104-125	1	IC,4-16 LINE DECODER		74HC154
U3	104-528	1	IC,8 BIT LATCH		P82C82
U4	104-661	1	IC,EPROM (PROGRAM)		27C256
U5	104-653	1	IC 8KX8 NOVRAM	DAL	DS1225Y
U6	104-310	1	IC,8 BIT MULTIPLEXER	NAT	DM81LS95
U7	104-210	1	IC,O.C. HEX INVERTER		7406
U8	104-207	1	IC,HEX INVERTER		74LS04
Y1	103-990	1	CRYSTAL,5.000 MHZ	MTRON	MP1 5.000 MHZ

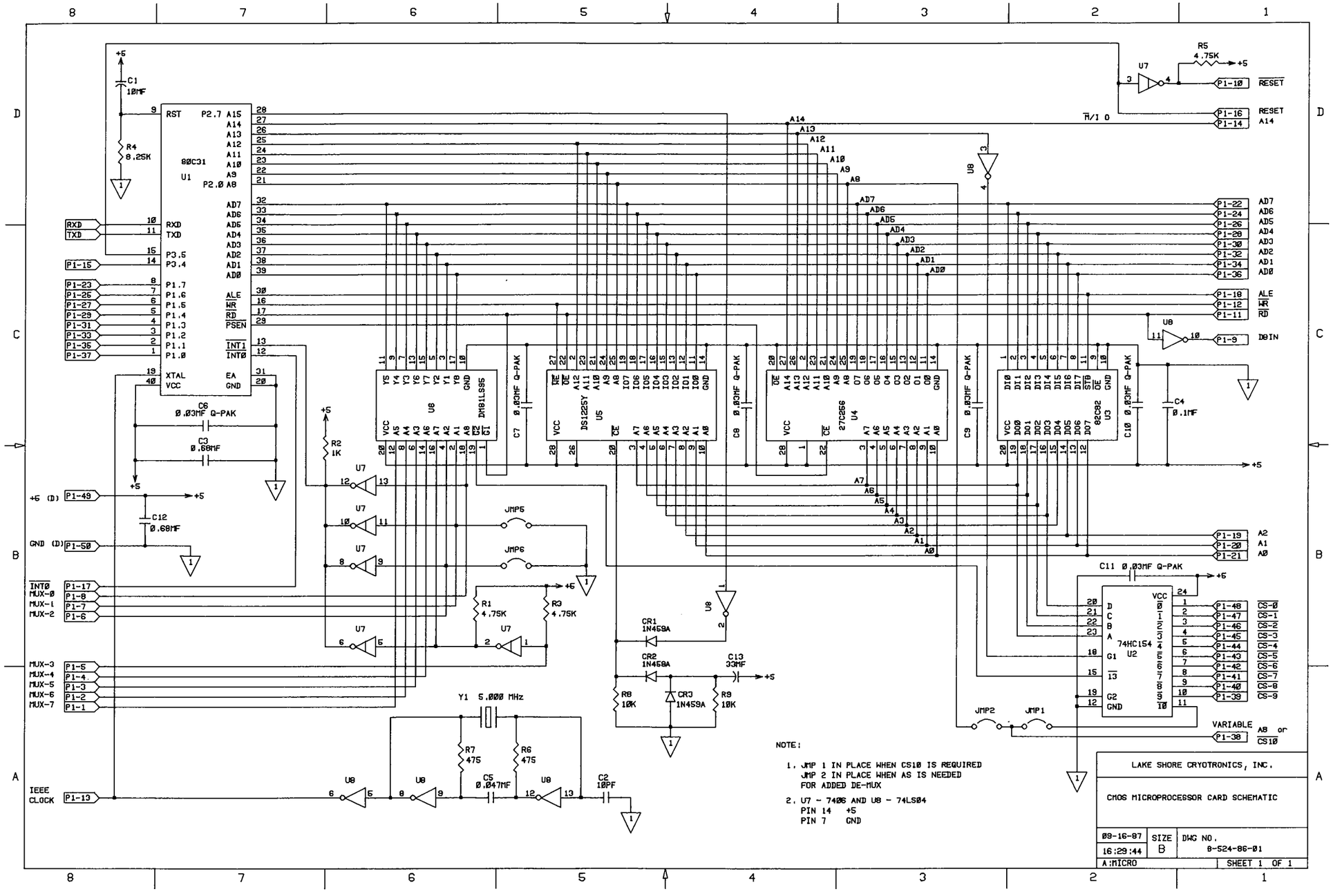
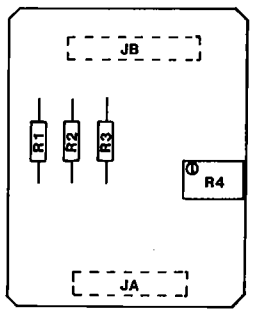


Figure 053. Microprocessor Card


JB
R1
R2
R3
R4
JA

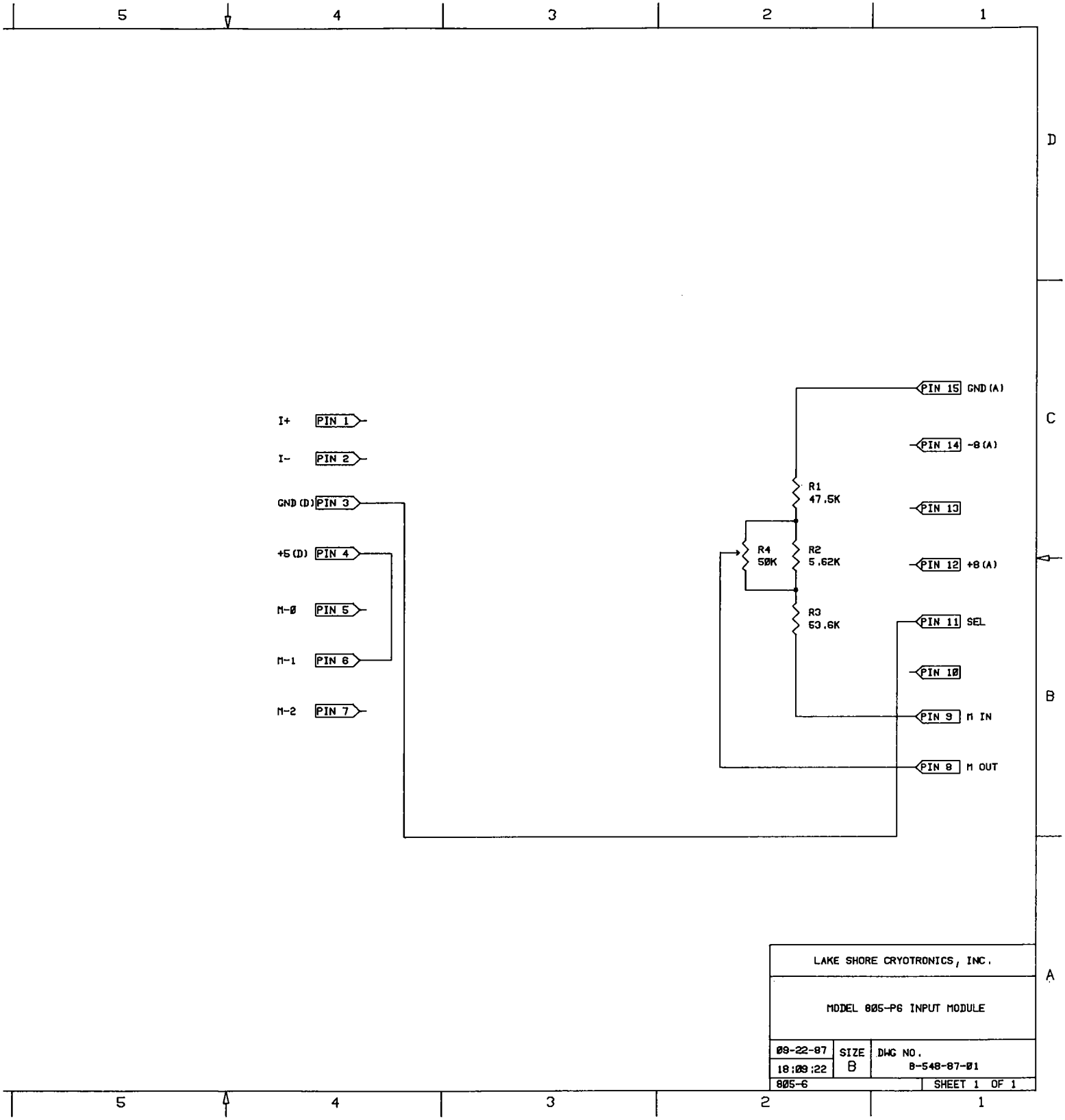
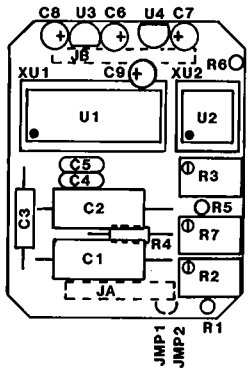
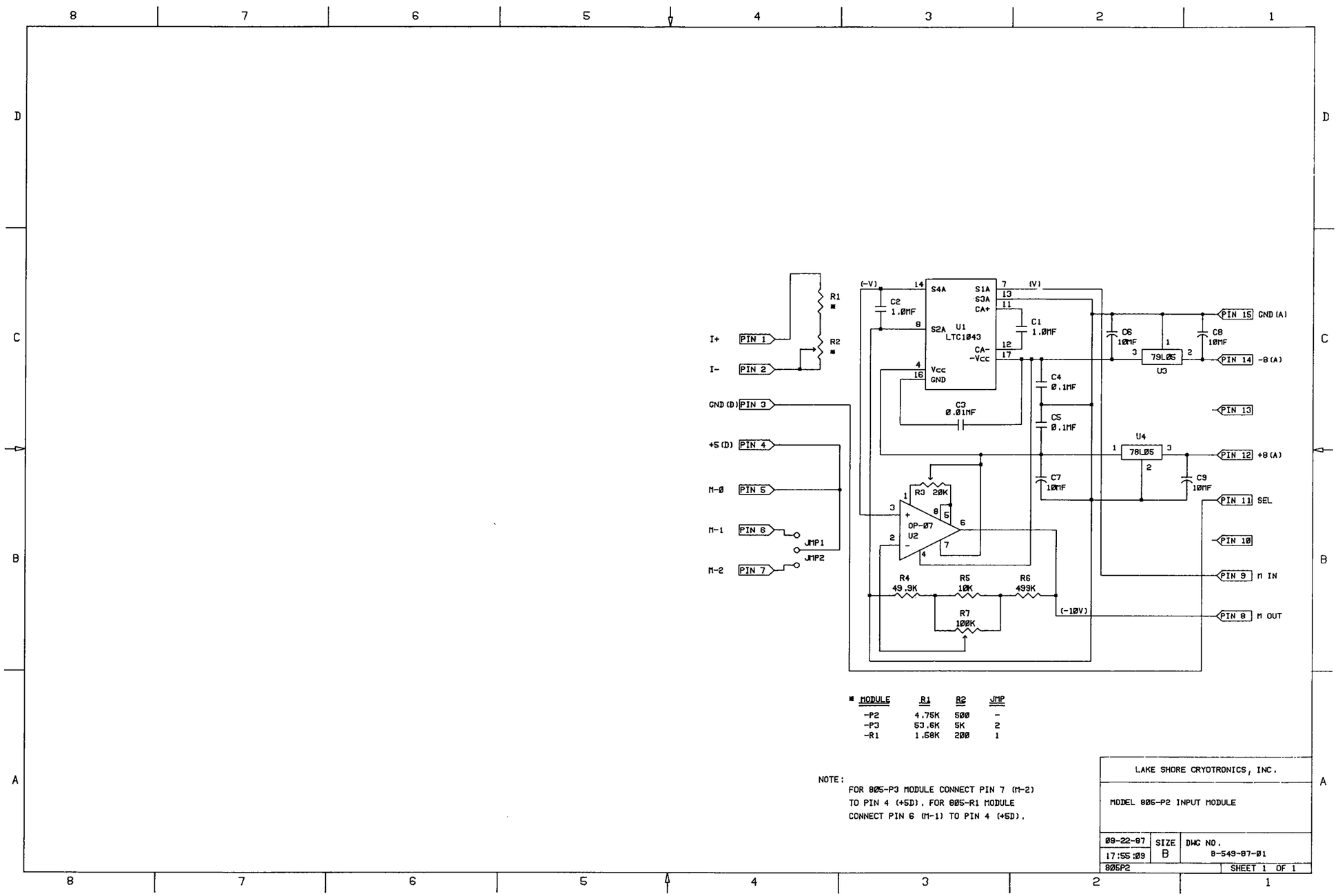


Figure 805-6. Model 805-6 Input Conversion Module



REPLACEABLE PARTS LIST - 805-P2,-P3,-R1 CONVERSION MODULE

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
U1	104-078	1	IC, SWITCHED CAPACITOR	LTC	LTC1043CN
U2	104-001	1	IC, OP AMP		OP07EP
U3	102-020	1	REGULATOR, -5V	MOT	UA79L05
U4	102-019	1	REGULATOR, +5V	MOT	UA78L05

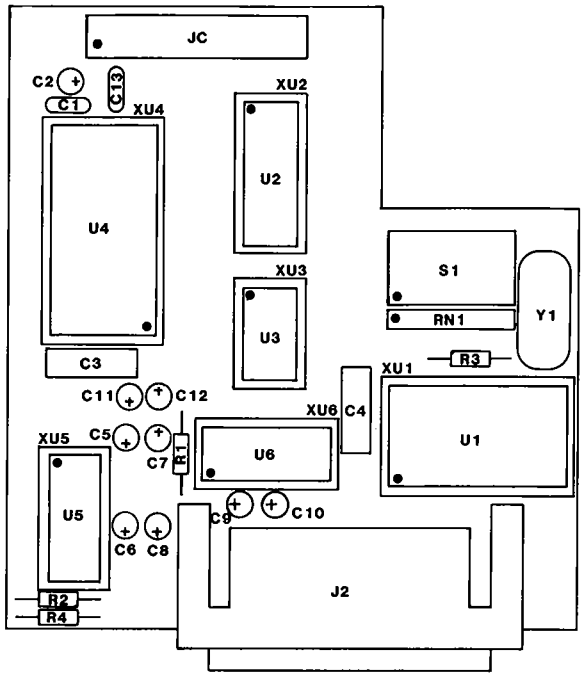


* MODULE	R1	R2	JMP
-P2	4.75K	500	-
-P3	53.6K	5K	2
-R1	1.58K	200	1

NOTE:
FOR 805-P3 MODULE CONNECT PIN 7 (M-2) TO PIN 4 (+5D). FOR 805-R1 MODULE CONNECT PIN 6 (M-1) TO PIN 4 (+5D).

LAKE SHORE CRYOTRONICS, INC.		
MODEL 805-P2 INPUT MODULE		
09-22-87	SIZE	DWG NO.
17:55:09	B	8-549-87-01
805P2		SHEET 1 OF 1

Figure 805-P2. Model 805-P2, -P3, -R1 Input Conversion Module



REPLACEABLE PARTS LIST - 8053 RS-232C INTERFACE OPTION

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
JC		1	CABLE (8053 TO MB)	LSCI	
J2	106-249	1	25 PIN RA D-STYLE CONNECTOR (RS-232C)	TRW	DBL-25S-2
S1	105-408	1	DIP SWITCH 8 POS	GYH	76SB08
U1	104-053	1	IC, BAUD GENERATOR	MOT	MC14411
U2	104-310	1	IC, 8 BIT MULTIPLEXER	NAT	DM81LS95AN
U3	104-203	1	IC, QUAD 2 INPUT NOR		74LS02
U4	104-523	1	IC UART	INT	P8251A
U5,6	104-722	1	IC, LINE DRIVER	LT	LT1080
Y1	103-991	1	CRYSTAL, 1.8432 MHZ	MTRON	MP-2-1.8432 MHZ

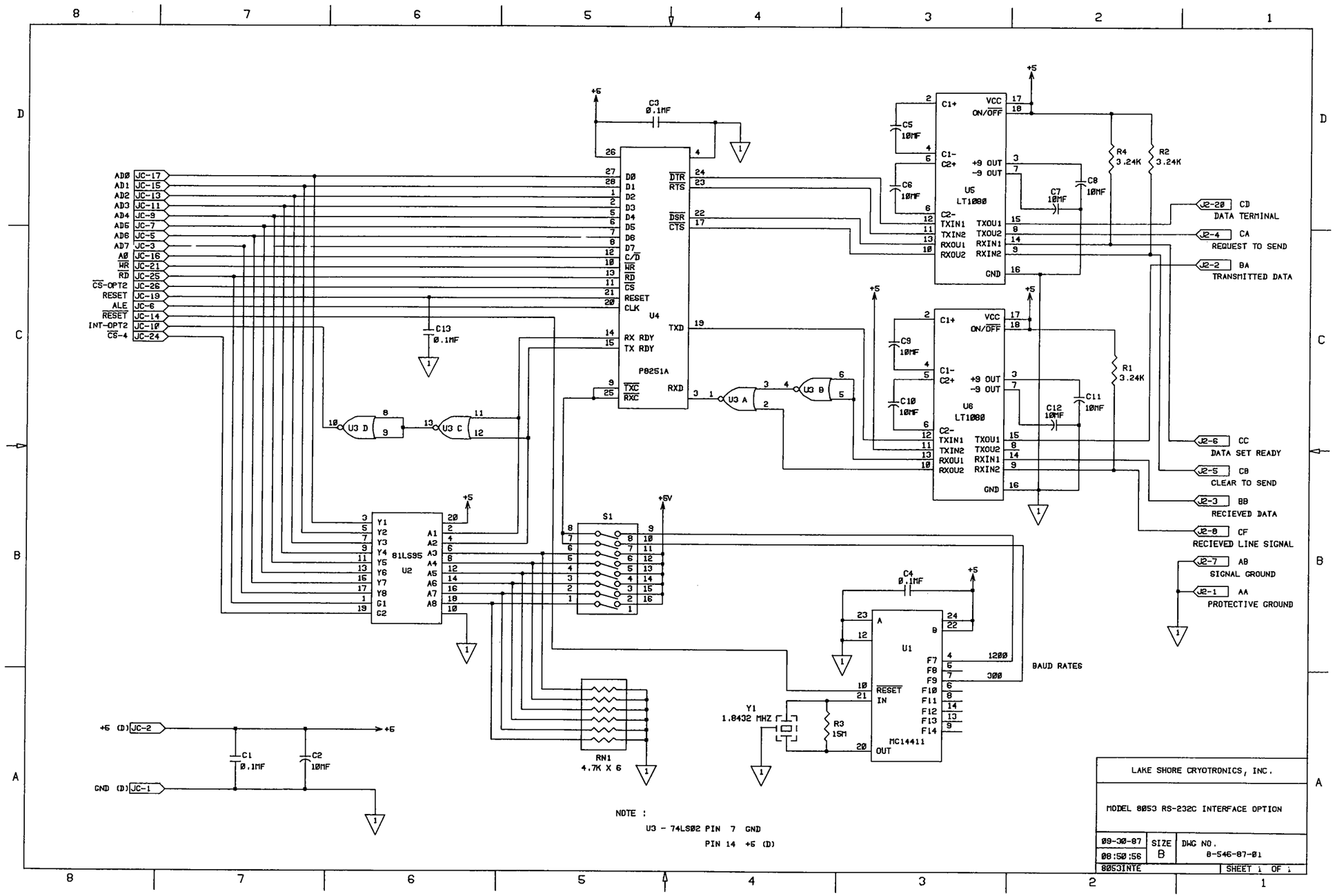
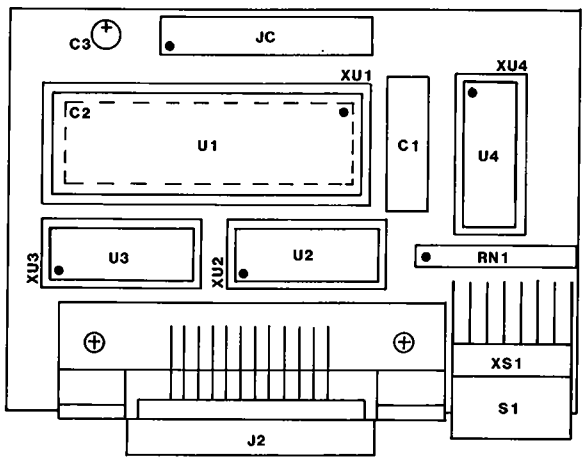


Figure 8053-1. Model 8053 RS-232C Interface Option



REPLACEABLE PARTS LIST - 8054 IEEE-488 INTERFACE OPTION

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
JC	106-428	1	CABLE (8054 TO MB)	LSCI	
J2	106-310	1	24 PIN RA D-STYLE CONNECTOR (IEEE)	AML	57-92245-12
S1	105-408	1	DIP SWITCH 8 POS	GYH	76SB08S
U1	104-712	1	IC, IEEE CHIP	TI	TMS9914ANL
U2	104-710	1	IC, IEEE SUPPORT CHIP	TI	SN75160AN
U3	104-711	1	IC, IEEE SUPPORT CHIP	TI	SN75161AN
U4	104-310	1	IC, 8 BIT MULTIPLEXER	NAT	DM81LS95AN

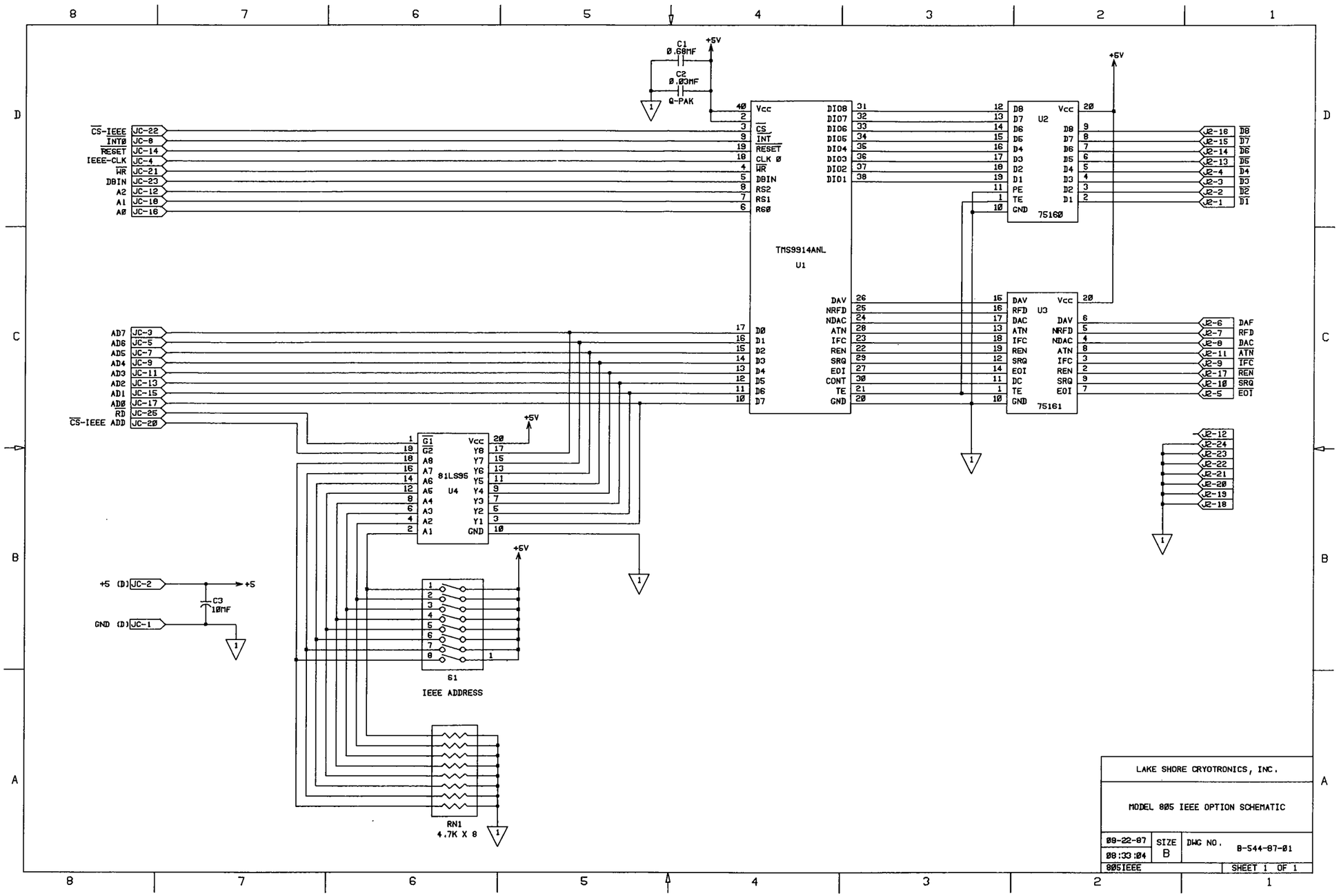
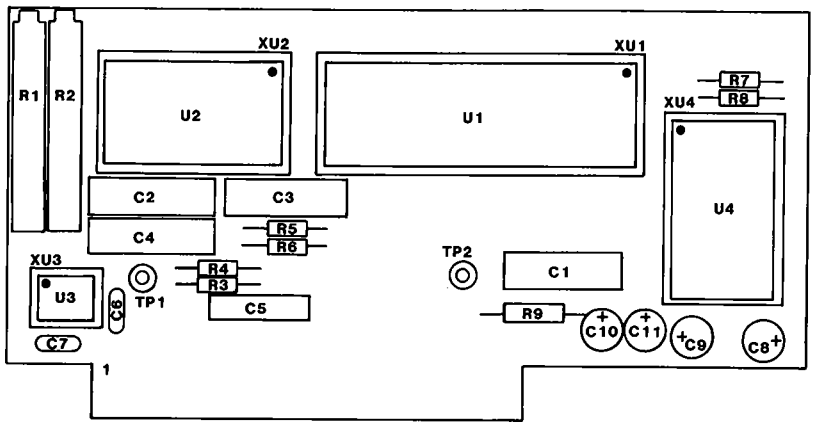


Figure 8054-1. Model 8054 IEEE-488 Interface Option



REPLACEABLE PARTS LIST - 8055 ANALOG OUTPUT OPTION

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
U1	104-529	1	IC, PORT EXPANDER	INT	P82C55A-5
U2	104-425	1	IC, D/A CONVERTER	BB	DAC71-CCD-V
U3	104-089	1	IC, OP AMP	MAX	MAX430CCP
U4	104-482	1	DC-DC CONVERTER	REL	V5R15-15

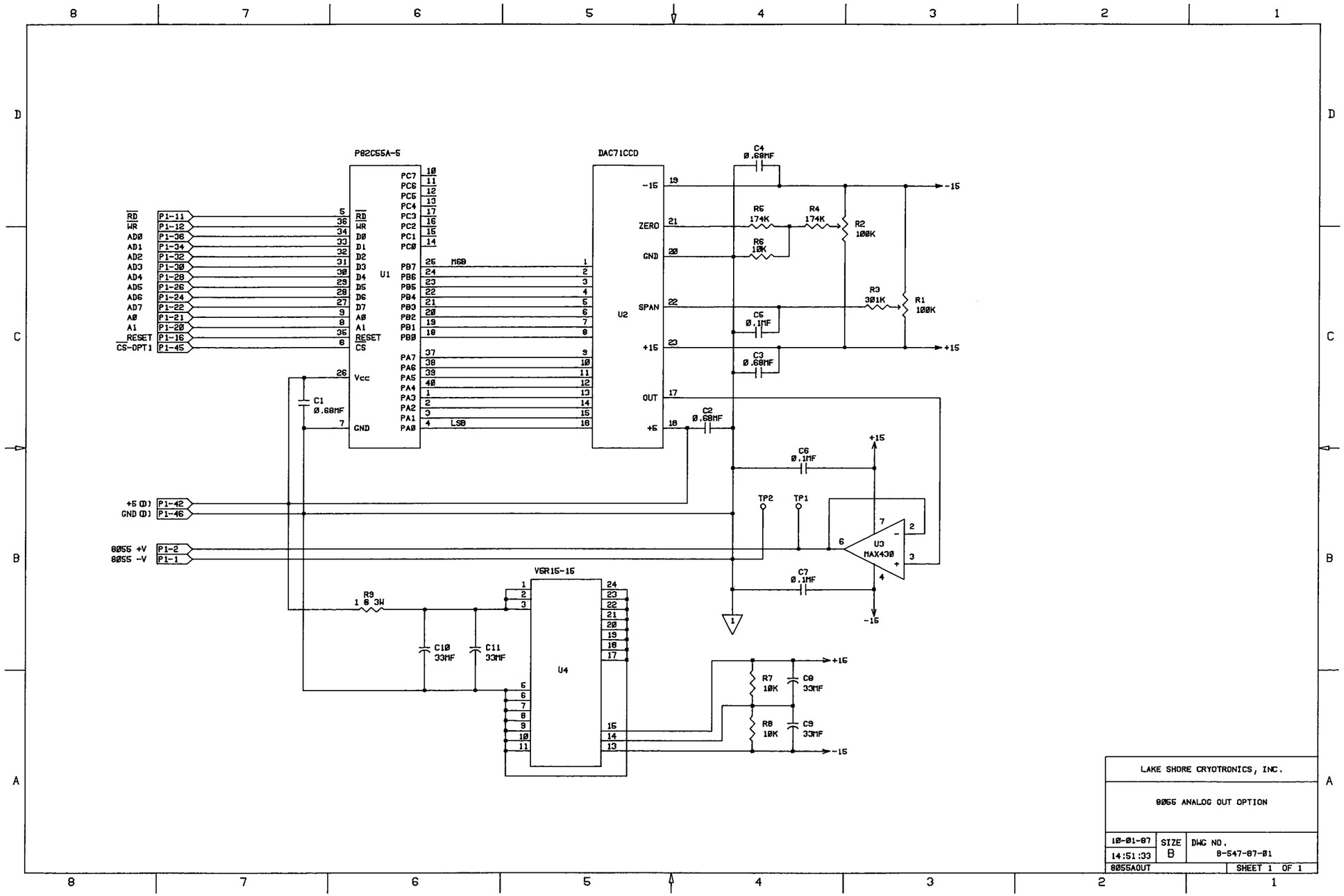
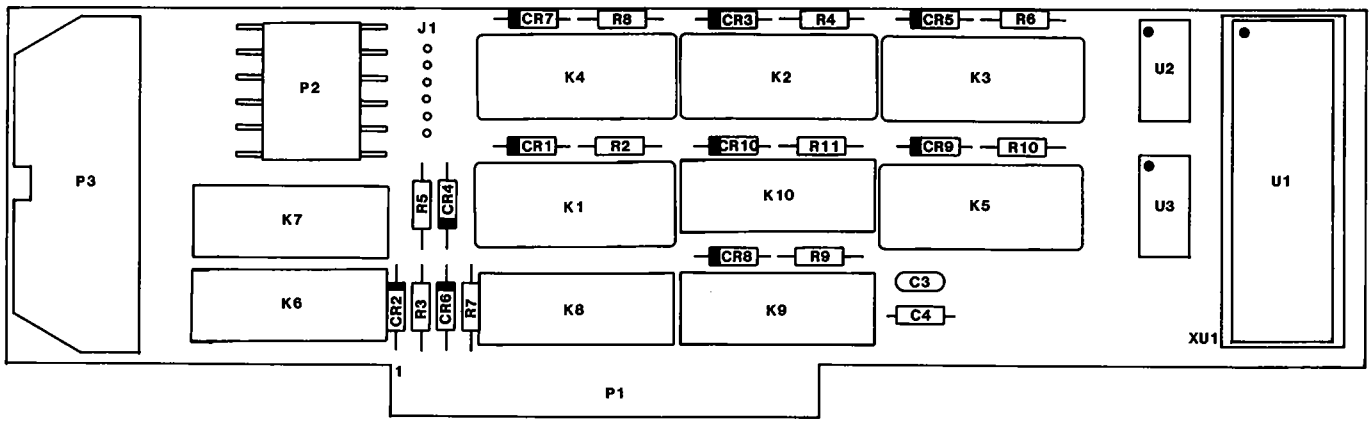


Figure 8055-1. Model 8055 Analog Output Option



REPLACEABLE PARTS LIST - MODEL 8229 SCANNER CONVERSION OPTION

ITEM NO	LSCI Part Number	Qty	Description	MFR	MFR PART NO
K1-5	105-321	5	RELAY,DPST,DRY REED	COTO	CR-3402-05-91
K6-10	105-322	5	RELAY,DPST,DRYREED	COTO	CR-7102-05-1010
MP1	106-250	1	CONNECTOR KIT	AML	57-30240
P2	106-142	1	6 POST LOCKING RA HDR	MOLX	2420-09075-1061
P3	106-424	1	26 PIN RA HEADER	TBA	609-2602MR
U1	104-524	1	IC, PORT EXPANDER	INT	P8255A-5
U2,3	104-210	2	IC, OC HEX INVERTER		7406

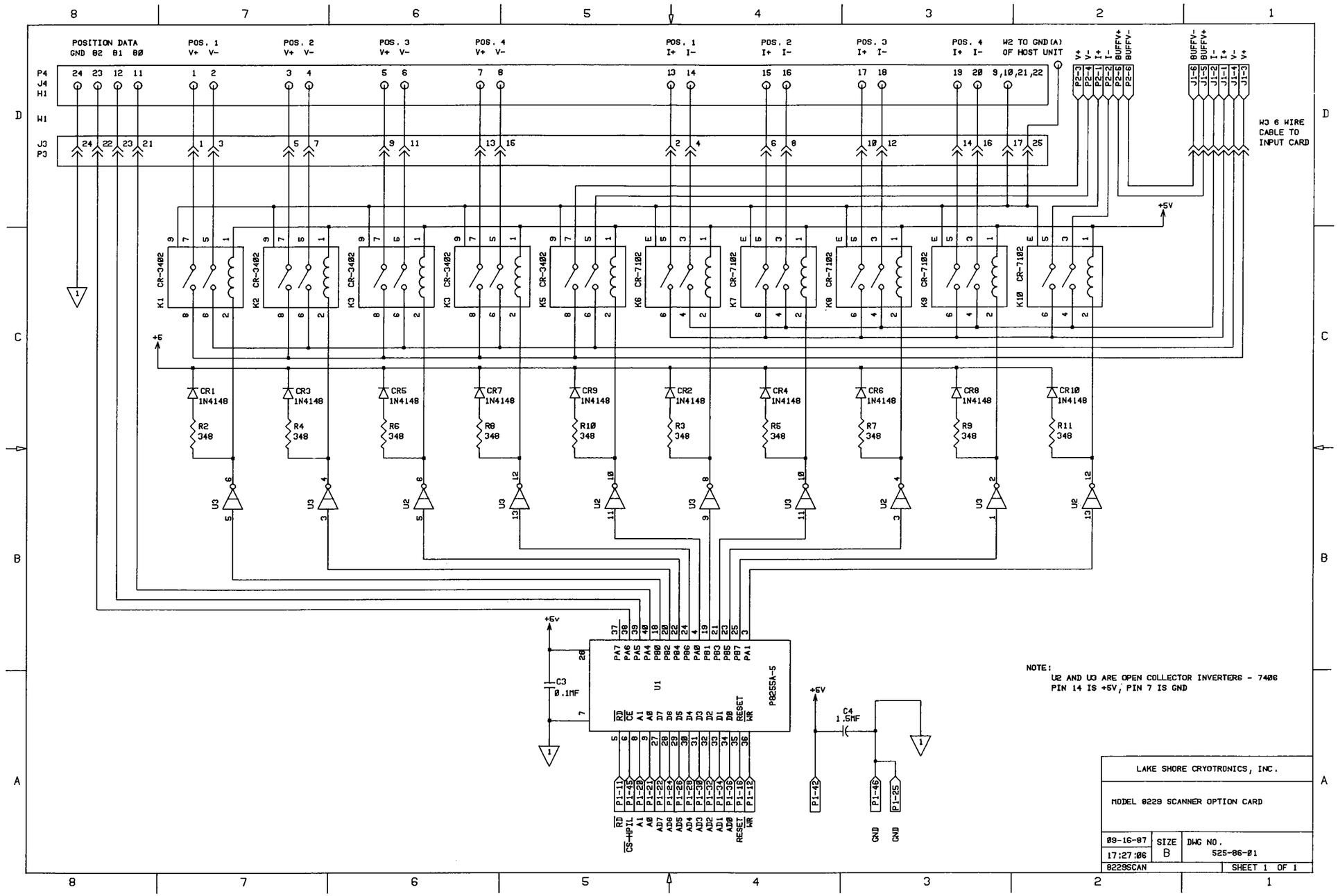


Figure 8229-1. Model 8229 Scanner Conversion Option